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Dallas, TX

Co-Editors: Michael Simonson and Margaret Crawford

Nova Southeastern University, North Miami Beach, Florida

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Selected Research and Development Papers
Presented at
The Annual Convention of the Association for Educational Communications and Technology
Sponsored by the Research and Theory Division
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Editors
Michael Simonson
Professor
Instructional Technology and Distance Education
Nova Southeastern University
Fischler Graduate School of Education and Human Services
North Miami Beach, FL
and
Margaret Crawford
School Media Specialist
Collins Elementary School
Broward County Schools, FL

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Preface

For the twenty-ninth year, the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is sponsoring the publication of these Proceedings. Papers published in this volume were presented at the national AECT Convention in Dallas, TX. A limited quantity of these Proceedings were printed and sold in both hardcopy and electronic versions. Volume #1 is available through the Educational Resources Clearinghouse (ERIC) System.

The Proceedings of AECT's Convention are published in two volumes. Volume #1 contains papers dealing primarily with research and development topics. Papers dealing with instruction and training issues are contained in volume #2.

REFEREEING PROCESS: Papers selected for presentation at the AECT Convention and included in these Proceedings were subjected to a reviewing process. All references to authorship were removed from proposals before they were submitted to referees for review. Approximately sixty percent of the manuscripts submitted for consideration were selected for presentation at the convention and for publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

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How Teacher Educators' Beliefs and Technology Uses Relate to Preservice Teachers' Beliefs and Attitudes toward Technology

Hua Bai
The State University of New York at Potsdam

Peggy Ertmer
Purdue University

Introduction

Beliefs about teaching and learning play an important role in transforming classrooms through the use of technology (Ertmer, 1999, 2005). Additionally, attitudes toward technology can influence teachers' technology uses (Myers & Halpin, 2002; Yildirim, 2000). In order to prepare preservice teachers to use technology effectively, it is necessary to examine their beliefs about learning and teaching and their attitudes toward technology. Teacher educators must act as role models for preservice teachers and prepare them to use technology in their future professional practices. In this paper we report the results of a study that examined teacher educators' beliefs and technology uses in relation to preservice teachers' beliefs and technology attitudes.

Ertmer (1999) described two types of barriers to technology integration: first-order barriers and second-order barriers. First-order barriers are extrinsic to teachers and include lack of access to hardware and software, time, and necessary support. Second-order barriers are intrinsic to teachers and include teachers' belief systems about teaching and learning, as well as their familiar teaching practices, which can affect meaningful technology integration. Since second-order barriers are more ingrained and personal than first-order barriers, they may be harder to overcome. Current literature (Becker, 2000; Niederhauser & Stoddart, 2001; Norm, Grabinger & Duffield, 1999) indicated that teachers who had more constructivist or student-centered beliefs tended to use technology and engage the students in more technology-supported student-centered learning activities, while those who had more traditional or teacher-centered beliefs tended to use less technology and had students use technology to reinforce skills.

Some researchers (Cifuentes, 1997; Daniel, 1996; Friel & Carboni, 2000; Hart, 2002) suggested that participation in teacher education programs could influence preservice teachers' beliefs. In teacher education courses, teacher educators create learning environments through specific teaching strategies that allow preservice teachers to experience models of teaching and learning that they might use in their future teaching. Supporting the strategies that teacher educators employ are their underlying beliefs about teaching and learning (Pajares, 1992). Since we may be able to predict teacher educators' teaching practices from their beliefs, and their practices are likely to influence preservice teachers' beliefs, it may be possible to predict preservice teachers' beliefs from teacher educators' beliefs. Thus, one of the research interests in this study was the relationship between teacher educators' beliefs and preservice teachers' beliefs.

Besides beliefs, attitudes are thought to serve as predictors of behaviors (Richardson, 2003). Applied to technology use, attitudes toward technology are expected to predict one's uses of technology. According to Aiken (1980), attitudes can be "learned directly by observing the activities of people who are perceived as significant" (p. 16). In teacher education programs, teacher educators serve as models for preservice teachers. Therefore, to better prepare technology-using teachers, teacher educators need to model technology use by integrating technology into their classes (Parker, 1997; Vannatta, 2000; Willis & Tucker, 2001). As Faison (1996) commented, "Teacher preparation programs must have delineated goals for technology infusion and provide consistent modeling of effective uses of technology in the classroom and in curriculum" (p. 58).

Abbott and Faris (2000) examined the attitudes of elementary education preservice teachers toward the use of computers before and after a semester-long site-based literacy course that integrated technology to support preservice teachers' understandings of elementary teaching. The participants' responses to the attitude surveys revealed an increase in positive attitudes toward computers after taking this course. In social studies education courses, Crowe (2004) modeled technology use and had prospective teachers work on technology-integrated projects. Most of the students felt that "the instructor's use of technology made them feel more comfortable that they could use technology in their teaching and that they had gotten ideas about how to use technology to enhance student learning from the activities in class" (p. 164). One student's comments specified, "the instructors' modeling – teaching with technology – was important for her to decide that she could teach with technology" (p. 164). It can be seen that preservice teachers' positive attitudes can be developed through their experiences in classes in which

teacher educators used computer technology to facilitate teaching and learning. Thus, one question arises: can teacher educators' technology uses predict preservice teachers' technology attitudes? To answer this question, we explored the relationship between teacher educators' technology uses and preservice teachers' technology attitudes.

Research Questions

The purpose of this study was to examine preservice teachers' pedagogical beliefs and attitudes toward technology in relation to teacher educators' pedagogical beliefs and their technology uses. Specifically the study intended to answer the following questions:

1. What is the relationship between teacher educators' beliefs and preservice teachers' beliefs?
2. What is the relationship between teacher educators' uses of technology and preservice teachers' attitudes toward technology?

Methods

To examine the research questions, a correlational research design was employed. Multiple regression techniques were used.

Participants and Site

The study was conducted with instructors and new teacher education students in a College of Education at a large mid-western university in spring 2005. The participants consisted of 96 new teacher education students from 11 teaching majors and 14 instructors from 3 teacher education courses, referred to here as A, B, and C. Specifically, six instructors were teaching course A, seven instructors were teaching course B, and one instructor was teaching course C. Course A and course B introduced students to general educational theory and practice. Students in these two courses formed a cohort, with all those attending one section of course A also taking the corresponding section of course B. Course C was an introductory educational technology course. All student participants took course A and course B. A total of 75 of the 96 students also took course C. The three courses were the only teacher education courses that these students took in the semester.

Data Collection

Data were collected through online surveys. At the beginning of the semester, a pre-survey was administered to the student participants to assess their current beliefs and attitudes toward technology. At the end of the semester, a post-survey was completed by the student participants to examine their beliefs and technology attitudes. The post-survey was similar to the pre-survey except that there were two open-ended questions asking students about their perceptions of the influence of their teacher education courses on their beliefs and technology attitudes. At the end of the semester, a survey was administered to instructor participants to examine their beliefs and technology uses in instruction.

Instruments

Teacher educators and preservice teachers' beliefs were measured by the *Teacher Beliefs Survey* (McCombs & Whisler, 1997). This survey contains 35 rating scale items. Three factors were identified: (a) learner-centered beliefs about learners, learning, and teaching (LB); (b) non-learner-centered beliefs about learners (NLB-L); and (c) non-learner-centered beliefs about learning and teaching (NLB-LT).

Preservice teachers' attitudes toward technology were measured by a questionnaire developed by Francis-Pelton and Pelton (1996). An exploratory factor analysis was conducted which yielded 4 factors (33 items). The researchers labeled the four factors as: educational benefits (EB), confidence (CF), impact on teaching (IT), and concerns about effects on students (CS).

Teacher educators' technology uses in instruction were measured through two sections of the survey. The first part of the survey measured the frequency of using a variety of tools and applications using questions from the Computer Tools/Applications section of a faculty survey (Lehman & Brown, 2001). The second part of the survey measured the ways in which the instructors required the student participants to use computer technology. This section contained 12 items that fell into two categories. One category included 8 items adapted from the survey

items in the studies conducted by Becker (2000) and Niederhauser and Stoddart (2001). This category measured the frequency with which instructors required students to use technology in constructivist ways. The other category contained 4 items adapted from the survey items in Becker's study (2000), which measured the frequency with which instructors required students to use technology in traditional ways.

Two open-ended questions were included at the end of the teacher educators' survey. The instructor participants were asked to state how they thought the students' teaching philosophies and technology attitudes might have developed as a result of taking their courses. Two open-ended questions were included at the end of the preservice teachers' post-survey. The student participants were asked to reflect on how the teacher education courses they took in the semester influenced their teaching philosophies and their attitudes toward technology.

Data Analysis

Descriptive data from the pre-survey and the post-survey were calculated for both students and instructors. To score students' attitudes toward technology, items stated negatively were coded with 1 indicating negative attitudes and 5 indicating positive attitudes. MANOVA (multivariate analysis of variance) was used to examine whether demographic data would make a difference in student participants' beliefs and technology attitudes prior to enrolling in the initial teacher education courses. The effect size of the multivariate η^2 is reported. In addition, t tests were conducted to see whether there was a significant change in students' beliefs and technology attitudes from pre-survey to post-survey. An effect size *d* was calculated. Besides three beliefs scores, data reported for instructors included the use of various computer tools and the ways in which teacher educators required the student participants to use technology. MANOVA tests were performed to examine whether the instructor participants' beliefs and technology uses were different across the three courses.

When testing the relationship between teacher educators' beliefs and preservice teachers' beliefs, sequential multiple regression analysis was conducted to examine each belief subscale separately. The students' post-survey beliefs scores were regressed as functions of instructors' beliefs scores. To control for the influence of student participants' pre-existing beliefs, their beliefs scores on the pre-survey were used as covariates in the regression analyses. Sequential multiple regression analyses were also performed when testing the relationship between teacher educators' technology uses and preservice teachers' technology attitudes. Students' post-survey attitudes scores were regressed as functions of instructors' technology use scores, and the students' pre-survey attitudes scores were used as the covariate. Since not all the student participants took course C, a dummy variable was used to indicate course C instructor's data in each multiple regression analysis.

When analyzing the participants' responses to open-ended questions, individual responses were examined. Responses reflecting identical or similar ideas were combined into one category. In this way, different categories were developed to demonstrate different perceptions on a particular question.

Results

Descriptive statistics of student participants' data are presented in Table 1. MANOVA tests results suggested no significant differences in beliefs scores (p = .42, $\eta^2 = 0.31$) or technology attitudes scores (p = .88, $\eta^2 = 0.30$) on the pre-survey among the students who were enrolled in different teaching majors.

Table 1
Descriptive Statistics of Students' Data (*N = 96*)

		Students' Beliefs			Students' Technology Attitudes			
		LB	NLB-L	NLB-LT	EB	CF	IT	CS
Pre-survey	*M*	3.28	2.08	2.79	3.70	4.07	4.34	3.74
	SD	0.29	0.37	0.37	0.40	0.71	0.41	0.58
Post-survey	*M*	3.30	2.16	2.64	3.86	4.15	4.30	3.74
	SD	0.34	0.45	0.40	0.56	0.58	0.53	0.70

Note. LB=learner centered beliefs; NLB-L=non-learner-centered beliefs about learners; NLB-LT=non-learner-centered beliefs about learning and teaching; EB=educational benefits; CF=confidence; IT=impact on teaching; CS=concerns about effects on students.

T-tests revealed that students' scores on non-learner-centered beliefs about learners on the pre-survey were significantly lower than their scores on the post-survey; $t[95] = 2.39$, $p = .02$, $d = .3$. Students' non-learner-centered beliefs about learning and teaching on the pre-survey were significantly higher than on the post-survey; $t[95] = -4.29$, $p < .0001$, $d = .4$.

When comparing those who took course C to those who did not, no significant difference was found among these groups on their pre-survey technology attitudes scores. On the post-survey, however, the technology attitudes scores, specifically related to educational benefits, for those who took course C were significantly higher than for those who did not take course C ($t[93] = 2.02$, $p = .025$ [one-tailed], $d = .5$), after deleting one outlier.

The instructor participants' data are presented in Table 2. MANOVA results indicated that they were not significantly different in their beliefs ($p = .47$, $\eta^2 = 0.24$) and technology uses ($p = .76$, $\eta^2 = 0.35$) across the three courses.

Table 2
Instructors' Beliefs and Technology Uses across Three Courses ($N = 14$)

		M	*SD*
Instructors' beliefs	LB	3.28	0.41
	NLB-L	2	0.47
	NLB-LT	2.20	0.43
Instructors' technology uses	Frequency of using various tools	1.98	0.27
	Frequency of requiring students to use technology in constructivist ways	2.94	0.58
	Frequency of requiring students to use technology in traditional ways	2.07	0.73

Note. LB=learner centered beliefs; NLB-L=non-learner-centered beliefs about learners; NLB-LT=non-learner-centered beliefs about learning and teaching.

Relationship Between Teacher Educators' Beliefs and Preservice Teachers' Beliefs

The regression analyses revealed that the learner-centered beliefs of the course A instructors were statistically significant ($p = .003$) in predicting students' learner-centered beliefs (see Table 3). The squared semi-partial correlation of .06 indicated that it explained 6% of the variance ($sr^2 = .06$) in the students' post-survey scores on learner-centered beliefs. As the covariate, the students' pre-survey scores on learner-centered beliefs explained 35% of the variance in the students' post-survey scores.

Table 3
Results of Regression Analysis of Learner-Centered Beliefs

Variable	*B*	R^2	*F*	*p*	β	sr^2
Step 1						
Students' LB on pre-survey	0.59	.34	47.57	<.0001*	.59	.35
Step 2						
Course A instructors' LB	0.32	.40	9.49	.003*	.25	.06
Step 3						
Course C instructor	-.04	.403	0.35	.56		
Step 4						
Course B instructors' LB	.01	.403	0.04	.84		

Note. B=raw regression coefficient; β=standardized regression coefficient; sr^2=squared semi-partial correlation.
*p<.05

No statistical significant results were found in regression analysis of non-learner-centered beliefs about learners. Table 4 reports the results of the regression analysis of non-learner-centered beliefs about learning and teaching. The non-learner-centered beliefs about learning and teaching of course A instructors were also statistically significant ($p = .02$) in predicting students' non-learner-centered beliefs about learning and teaching and explained 4% of the variance in students' post-survey scores ($sr^2 = .04$). As the covariate, the students' non-learner-centered beliefs about learning and teaching were significant ($p < .0001$) and explained 44% of the variance in students' non-learner-centered beliefs about learning and teaching on the post-survey ($sr^2 = .44$).

Table 4
Results of Regression Analysis of Non-Learner-Centered Beliefs About Learning and Teaching

Variable	*B*	R^2	*F*	*p*	β	sr^2
Step 1						
Students' NLB-LT on pre-survey	0.69	.43	68.72	<.0001*	.67	.44
Step 2						
Course A instructors' NLB-LT	0.25	.46	6.15	.02*	.19	.04
Step 3						
Course C instructor	0.07	.47	.84	.36		
Step 4						
Course B instructors' NLB-LT	-0.02	.47	.07	.80		

Note. B=raw regression coefficient; β=standardized regression coefficient; sr^2=squared semi-partial correlation.
*p<.05

According to the students' responses to the open-ended questions, students perceived that all three courses influenced their teaching philosophies in one way or another. The majority (n = 67) of the student participants reflected that taking course A positively influenced their teaching philosophies. This course gave them insights into teaching and learning, and helped them learn how to be a teacher. This finding helped to understand the quantitative findings that course A instructors' learner-centered beliefs and non-learner-centered beliefs about learning and teaching were significant in predicting students' beliefs.

Relationship Between Teacher Educators' Technology Uses and Preservice Teachers' Technology Attitudes

A significant predictive relationship was found between teacher educators' technology uses and preservice teachers' technology attitudes related to education benefits. Since the variable of "frequency that instructors had students use technology in constructivist ways" was highly correlated to the variable of "frequency that instructors had students use technology in traditional ways", the two variables were included in separate regression models. The results are presented in Table 5 and Table 6.

Table 5
Results of Regression Model 1 in Predicting Students' Technology Attitudes Related to Education Benefits

Variable	*B*	R^2	*F*	*p*	β	sr^2
Step 1						
Students' attitudes on pre-survey	0.77	.38	55.91	.0006*	.62	.38
Step 2						
Course C instructor	0.28	.44	9.24	.016*	.21	.04
Step 3						
Use of tools by course A instructors	-0.27	.46	4.05	.16		
Step 4						
Constructivist use by course A instructors	0.14	.47	1.98	.40		
Step 5						
Constructivist use by course B instructors	-0.14	.48	1.71	.44		
Step 6						
Use of tools by course B instructors	-0.14	.48	0.36	.81		

Note. B=raw regression coefficient; β=standardized regression coefficient; sr^2=squared semi-partial correlation.
*p<.05

Table 6

Results of Regression Model 2 in Predicting Students' Technology Attitudes Related to Education Benefits

Variable	B	R^2	F	p	β	sr^2
Step 1						
Students' attitudes on pre-survey	0.77	.38	55.91	.0006*	.62	.38
Step 2						
Course C instructor	0.28	.44	9.24	.016*	.21	.04
Step 3						
Use of tools by course A instructors	-0.27	.46	4.05	.16		
Step 4						
Use of tools by course B instructors	-0.26	.47	1.44	.50		
Step 5						
Traditional use by course A instructors	0.11	.472	0.69	.72		
Step 6						
Traditional use by course B instructors	-0.02	.473	0.17	.90		

Note. B=raw regression coefficient; β=standardized regression coefficient; sr^2=squared semi-partial correlation.
*p<.05

As the covariate, it is not surprising to find that the students' attitude scores on the pre-survey were the strongest predictor of their attitude scores on the post-survey. The dummy variable representing course C instructor was significant (p = .016) in predicting students' technology attitudes related to the educational benefits. That is, taking this course had a positive relationship to students' technology attitudes (β = .21) and explained 4% of the variance (sr^2 = .04) in the students' post-survey scores. No significant relationship was found between the instructors' technology uses and the students' attitudes related to confidence, impact on teaching, or concerns about effects on students.

The analysis of the student participants' responses to the open-ended question showed that 55 out of 75 students who took course C thought that this course had influenced their attitudes toward technology. This course taught them how to integrate computer technology into classes and helped them realize the importance and usefulness of technology in education. Few of them mentioned courses A or B. In response to the open-ended questions, course C instructor thought the overall influence of this course was to help the students see the power of technology in facilitating teaching and learning. In general, the instructors in courses A and B did not think the students' technology attitudes were influenced by their courses since the students were not exposed to technology a lot in the classes. This supports the quantitative findings that no positive relationship was found between the instructors' technology uses in course A and course B and students' technology attitudes.

Discussion and Implications

Beliefs

An important goal of teacher education programs is to help preservice teachers identify and develop their beliefs in relation to teaching. In teacher education programs, preservice teachers' entering beliefs may be "challenged through classroom readings, dialogue, and classroom experimentation" (Richardson, 2003, p. 1). By means of these activities, it is expected that teacher educators can share their perceptions and ideas about teaching and learning with the students. This study revealed that the instructors' learner-centered beliefs and non-learner-centered beliefs about learning and teaching had an influence on the students' beliefs, however, the influence was small over the course of one semester. According to Richardson (2003), preservice teachers' entering beliefs are usually deep-seated. This is supported by the findings in this study in which students' beliefs scores on the pre-survey were always the strongest predictors of their scores on the post-survey. Expecting teacher educators' beliefs to have a great influence on preservice teachers' beliefs over a single semester may have been unrealistic. Future research should examine the predictive relationship between teacher educators' beliefs and preservice teachers' beliefs over a longer period of time.

Interestingly, the results of this study indicated that only course A instructors' beliefs were significant in predicting students' beliefs. Furthermore, the majority of the student participants noted that taking course A positively influenced their teaching philosophies and helped them learn how to be teachers. It is possible that course A instructors had different beliefs than the other instructors and that these differences may have manifested themselves in their classroom activities. Alternatively, it is possible that these instructors simply discussed their

beliefs more readily, and engaged their students in activities that allowed them to reflect on their own beliefs and ideas.

Although it is hard to change deep-seated beliefs, such as those that preservice teachers may bring with them to their teacher education programs, this is *not* impossible, which has been indicated by some studies (Cifuentes, 1997; Daniel, 1996; Friel & Carboni, 2000; Hart, 2002). In addition, it is likely that these changes do not occur evenly over time, but rather in starts and stops as existing beliefs are subjected to deeper reflection, such as when they are challenged by new information or opposing beliefs. For example, in this study, preservice teachers' non-learner-centered beliefs about learning and teaching were significantly weaker at the end of the semester than at the beginning, however, their non-learner-centered beliefs about learners were significantly stronger at the end of the semester. This suggests that as preservice teachers decreased their beliefs about teacher control, they tended to become more concerned about students' ability to succeed in the learning process. In practice, teacher educators may need to be aware of the possible difference in the development of preservice teachers' non-learner-centered beliefs and discover ways to address them simultaneously. According to McCombs and Whisler (1997):

> We found that when teachers' beliefs about learners were non-learner centered (that is, when teachers did not believe that all students can be helped to learn), then students tended to perceive classroom practices in negative ways. And when student perceptions were negative, both student motivation and classroom achievement were low (p. 199).

Thus, teacher educators need to pay particular attention to the development of preservice teachers' non-learner-centered beliefs about learners. As teacher educators help preservice teachers understand students' roles in the teaching and learning process, it is very important to help them also realize the uniqueness of each learner and to understand how to support students' learning.

Significant changes in preservice teachers' beliefs may require long-term efforts throughout the entire teacher education program. It is expected that teacher educators could engage students in learning activities that allow them to experience, to reflect, and then to modify their beliefs. Teacher educators' guidance is important. In this process, hopefully, teacher educators' beliefs could be projected through teaching practices to influence students' beliefs.

Technology Attitudes

Research (Abbott & Faris, 2000; Crowe, 2004; Kumar & Kumar, 2003) suggested that preservice teachers' attitudes toward technology may be improved if teacher educators integrated technology into teacher education course work. In this study, it was found that teacher educators' technology uses, in terms of using computer tools/applications and requiring students to use technology in different ways, did not predict students' technology attitudes. However, taking course C, an introductory educational technology course, was found to be statistically significant in predicting students' technology attitudes related to educational benefits. Unfortunately, this cannot be directly related to course C instructor's technology uses, but rather to taking a course that provided relevant information about how and why to use a variety of technologies in the classroom as well as a range of hands-on experiences.

Although the results of this study did not do justice to the assumption that teacher educators' technology uses could predict preservice teachers' technology attitudes, one should not jump to the conclusion that preservice teachers' technology attitudes are not related to teacher educators' technology uses. According to the comments made by the instructors in course A and course B, the students were not exposed to much technology in their courses, therefore, they did not expect the students' attitudes toward technology to have been influenced. Thus, one possible explanation for the lack of positive relationship between the instructors' technology uses and the students' attitudes may be that the instructors' technology uses were not at a level that could be influential. Although instructors had a certain amount of technology use, such use may not have been enough to influence the students' technology attitudes. To better explore this relationship in the future, data could be collected from new teacher education students and teacher educators who use more technology and use them at a higher level.

The regression results revealed that taking course C made a small contribution to the prediction of students' attitudes over one semester. Additionally, the t-tests results indicated that taking this introductory educational technology course was helpful for improving preservice teachers' technology attitudes related to educational benefits. While the student participants tended to have positive technology attitudes related to confidence and impact on teaching *before* they entered the teacher education program, their attitudes related to educational benefits and concerns about effects on students were not very positive. Furthermore, at the start of the study, those who took an

introductory educational technology course and those who did not take the course did not significantly differ in their attitudes related to educational benefits. However, at the end of the semester, those who took the course had significantly stronger attitudes than those who did not take the course. The students' comments on the influence of course C on their attitudes mainly centered upon the usefulness and importance of technology in education. This suggests that in teacher education programs, it may be important for students to take an educational technology course that presents ideas about how to integrate technology. Such an introductory course will not only provide students with foundational knowledge and skills related to educational technology, but also facilitate their positive attitudes toward technology use in education. This will increase the possibility that preservice teachers will use technology in their future teaching practice (Myers & Halpin, 2002; Yildirim, 2000).

Preservice teachers need to witness and experience technology use in a pedagogically sound manner as students, and then hopefully they will implement that in their own teaching. Facilitating preservice teachers' positive attitudes toward technology should not only be the responsibility of teacher educators in technology courses. It requires the joint efforts of all teacher educators.

Limitations and Recommendations for Future Research

According to Richardson (1996), the measurement of teachers' beliefs in the form of multiple-choice is "too constraining" (p. 107). Richardson further commented that multiple-choice measures of beliefs that are predetermined by the researchers "often do not validly represent teachers' beliefs" (p. 107). Due to the design of this study, a multiple-choice test was selected to measure the beliefs. However, it is recommended that, if possible, a qualitative study be designed to explore the relationship between teacher educators' beliefs and preservice teachers' beliefs. Hopefully, a qualitative approach will provide rich and in-depth exploration and a better description of the relationship.

In the future, when time and funding permits, a longitudinal study could be conducted to examine the development of preservice teachers' beliefs over the course of their teacher education programs. Since preservice teachers usually have strong and deep-seated beliefs when they enter the teacher education program, a study on the development of their beliefs over a long period could provide more useful information for practitioners and researchers.

A small sample size may have influenced the results of this study. In the future, when conducting similar studies, a large sample size is recommended. Finally, as discussed earlier, one possible explanation for the lack of a predictive relationship between teacher educators' technology uses and preservice teachers' technology attitudes may be that the instructors' technology uses were not at a level that could be influential. To better examine this issue, it is recommended that a comparative study be conducted to examine the difference of influence on preservice teachers' technology attitudes between those teacher educators who expose students to more technology experiences and those who do not expose students to a lot of technology experiences.

Conclusion

Preservice teachers' beliefs and technology attitudes are two important issues in teacher education programs. This study examined these issues in relation to teacher educators' beliefs and technology attitudes. The results were reported and discussed, which also provided avenues for future studies. It is expected that such exploration would enrich our knowledge about how to prepare technology-using teachers and suggest good practices for teacher educators.

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Cognitive Load in Online Reading

Shujen L. Chang
University of Houston
Yegmin Chang
National Cheng-Chi University

Abstract

This study investigated the effects of different material formats (paper, online-linear, and online-nonlinear) on reading comprehension and time needed to complete reading from a cognitive load perspective. One hundred and thirty five undergraduate students participated in the experiment. Significant differences of reading comprehension and time were found among groups using different material formats, while participants reported no significant differences in content and format cognitive loads among groups.

Introduction

Educators have noted that online reading adversely influenced reading comprehension (Patterson, 2000; Shapiro, 1998; Shapiro & Niederhauser, 2004). This influence may be attributed to the format of online material and cognitive load required for reading online material. The format of online material was changed from traditional linear paper format to nonlinear multi-window format (Barker & Tedd, 1999; Quinlan, 1997; Wiley & Schooler, 2001); reading nonlinear multi-window material might require greater cognitive load (Britt & Gabrys, 2001; Hill & Hannafin, 2001; Yang, 2001). However, is online reading comprehension affected by the nonlinearity of online material formats or by reading from a digital display on screen instead of paper? Do different material formats require a change in cognitive load and therefore need various lengths of time to complete reading? Does the content or the format of reading material cause increase in cognitive load? These questions have not been empirically inspected so far.

This study investigated the effects of the different material formats (paper, online-linear, and online-nonlinear) on reading comprehension and the length of time needed to complete reading from a cognitive load perspective. Reading comprehension referred to the score a participant earned from the reading tests. The length of time referred to how many minutes a participant used to complete reading and tests. The content and the format cognitive loads were participants' report of the extent of perceived mental effort spent with respect to the content or the format of reading material. The research question examined whether reading different material formats would require various levels of the content and the format cognitive loads, which would subsequently interfere reading comprehension and require more time to complete the readings.

Method

Design

One hundred and thirty five undergraduate students (95 females and 35 males) of College of Commerce at a large state university in Taiwan participated in this study voluntarily. This study was a three-group randomized experimental design. Each group received the same reading material but in a different format. This study observed two dependent variables, reading comprehension and time, with two covariates, content and

format cognitive loads under the treatment – three different material formats: paper, online-linear, and online-nonlinear.

Reading Material

The reading material included three short reading passages in Chinese and each passage was followed by a test containing 5 multiple-choice questions. All groups received the same content of the reading material but in different formats. The paper format linearly displayed passages and tests on paper; although linearly, the online-linear format presented passages and tests on computer screen within a single-window; and the online-nonlinear format displayed a list of three links on screen and each link opened a new window displaying the corresponding passage and test. All groups were asked to record answers of tests on the given answer sheet.

Variables

The two dependent variables were reading comprehension and time used to complete reading and tests. Reading comprehension was measured by the total score that a participant earned from the three reading tests; the time was the number of minutes used to complete reading and tests reported by participants.

The two covariates were content and format cognitive loads referred to participants' report of the extent of self-perceived mental effort invested in reading comprehension with respect to the content and the format of reading material. Content and format cognitive loads were measured via two cognitive load questions on a subjective 9-point rating scale developed by Paas (1992).

Procedure

The researchers, first, explained the purpose of this study and randomly assigned participants into three groups: the paper group in a regular classroom and the two online groups in a computer laboratory with Internet connection. Second, the researchers distributed and explained instruction with the answer sheet. Finally, the researchers collected answer sheets after participants finished the experiment.

Data Analysis

MANCOVA tests with content and format cognitive loads as two interactive covariates were used to determine whether there were differences concerning the effects of different material formats on reading comprehension and time. MANOVA tests were also employed to determine whether different formats required different amount of content and format cognitive loads. Scatter plots and Pearson correlations were used to determine the association between reading comprehension and time. A priori of .05 significance level was used for all statistical tests in this study.

Results

Reading comprehension and time had means 11.75 points (SD = 1.90) ranging from 5 to 15, and 13.96 minutes (SD = 2.93) ranging from 5 to 15 minutes. Content and format cognitive load had means 14.80 (SD = 4.01) and 14.16 (SD = 4.31) on a 9-point scale, respectively.

MANCOVA tests indicated significant differences among groups in reading comprehension and time while content and format cognitive load were used as covariates (Pillais' Trace p = .01). Tests of between-subject effects also indicated significant differences among groups in reading comprehension (p = .01) and time (p = .05). On reading comprehension, the paper group achieved the highest score (M = 12.24), the online-nonlinear group achieved the medium score (M = 11.74), and the online-linear group

achieved the lowest score (*M* = 11.28). As to time, the paper group used the shortest time (*M* = 13.24), the online-linear group used the medium time (*M* = 13.65), and the online-nonlinear group used the longest time (*M* = 15.05). However, scatter plots and Pearson correlations indicated no significant correlation between reading comprehension and time ($r = .01$, $p = .94$).

MANOVA tests indicated no significant differences among groups concerning content and format cognitive loads (Pillais' Trace $p = .62$, Partial Eta Squared = .01, Observed Power = .21). Also, tests of between-subject effects indicated no significant differences among groups concerning content cognitive load ($F = .60$, $p = .55$) and format cognitive load ($F = .11$, $p = .90$).

Discussion

Reading Comprehension

Significant differences of reading comprehension were found among groups using different formats of reading. Specifically, the paper group outperformed both online-linear and online-nonlinear groups on reading comprehension. The finding confirms with previous findings that online reading does interfere reading comprehension (Patterson, 2000; Shapiro, 1998; Shapiro & Niederhauser, 2004). However, the finding that online-nonlinear group outperformed the online-linear group on reading comprehension is not in line with previous studies (Britt & Gabrys, 2001; Hill & Hannafin, 2001; Yang, 2001). This finding implies that online-linear material may not facilitate reading comprehension. Specifically, scrolling up and down on screen to read online linear material may interfere reading comprehension the most, compared to flipping through paper or clicking links.

Time

Consistent with our hypotheses, the time used to complete reading and tests was found significantly different among groups. Specifically, the paper group used the shortest time, the online-linear group used the medium time, and the online-nonlinear group used the longest time. This finding indicates that reading online, compared to paper, material takes more time because of the required additional activities for online reading, such as scrolling on screen and navigating multi-windows. Also, navigating between multi-windows may take more time than scrolling on screen because additional time is needed to access multi-windows. Thus, online instruction should allow more time for online reading. In addition, it was found that there was no significant correlation between time and reading comprehension. This finding suggests that the additional time needed for online learning may not affect online learning effectiveness.

Content and Format Cognitive Loads

Participants using different formats reported no significant differences in perceived content and format cognitive loads, contrary to previous studies (Britt & Gabrys, 2001; Hill & Hannafin, 2001; Yang, 2001). The short length of reading passages in this study may not create significant variations in content and format cognitive loads among groups.

In summary, this study found that reading comprehension and time needed for completing reading were significantly affected by material formats (paper, online-linear, and online-nonlinear). However, participants using different formats reported no significant differences of perceived content and format cognitive loads.

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Investigating the Use of Advance Organizers as an Instructional Strategy for Web-based Distance Education

Baiyun Chen, Atsusi Hirumi
University of Central Florida

Abstract

It is synthesized that advance organizers (AOs), an effective orienting device in traditional classroom instruction, may enhance students' information literacy in self-directed online classes. The current study investigated the short-term and long-term effects of two types of advance organizers, graphic and text, in a fully Web-based undergraduate course on health care ethics. Although the results failed to yield a statistically significant difference regarding the use of AOs among treatment groups and the control group, additional qualitative data indicated that students held overwhelmingly positive attitudes towards using AOs, especially the concept map, in online learning. The analyses and results of this study added new empirical evidence for the use of AOs in Web-based distance education and posited new directions for further research.

In fully Web-based courses, the use of hyperlinked multimedia resources often bring challenges of cognitive overload and learner disorientation (Dias & Sousa, 1997). While the learners enjoy the flexibility and abundance of Internet resources, they may also be overwhelmed with multiple tasks and sources of information. As distant learners, the students cannot always obtain immediate feedback from instructors, and need to make decisions on their own to locate course materials and complete assignments. While they recognize hyperlinks as a method for accessing electronic resources and navigating online courses, these students are likely to experience greater difficulties than students in instructor-led, face-to-face classes in terms of navigation and guidance. To better exploit the capabilities of technology, the adoption of effective online teaching and learning strategies is suggested to resolve online learning challenges (Bonk & Dennen, 2003).

What kind of teaching and learning strategy exists for effective Web-based learning? Unfortunately, there is limited research to prove the effectiveness of learning strategies in fully Web-based environments. While many studies have shown no significant difference between online courses and traditional courses, applying traditional learning strategies at a distance often causes frustrations (Howell, Williams, & Lindsay, 2003). The literature reveals an increasing need to exploit research-based pedagogical strategies in fully Web-based environments.

Distance Education

Online learning has become pervasive in higher education. According to the latest survey, nearly two-thirds of all colleges and universities that deliver face-to-face instruction now offer online instruction, and the enrollment in 2004 in Web-based courses reached 2.35 million, up nearly 20% over the 2003 figures (Allen & Seaman, 2004, 2005).

Both students and instructors perceive that online learning provides major benefits. The biggest benefit is convenience. Students can access learning materials at virtually anytime and almost any place. Also, the Internet brings expanded resources to the learners at a very low cost. Recently, multi-media learning environments have been created with audio, video, graphic and animation to simulate true tasks which bring tremendous interests and motivation to learners. For the instructor, online teaching can also be beneficial in terms of structure and time, increased student outreach and contact, personal satisfaction, availability of expanded research tools, improved course management, and the ability to learn new technologies (Hartman, Dziuban, & Moskal, 2000).

At the University of Central Florida (UCF), online courses have become one of the major learning modalities. In the academic year of 2004-2005, 29,187 students, accounted for 65% of the total student population, were enrolled in the fully web-based classes (Center for Distributed Learning, 2006). Every semester, more than 180 online courses have been offered through WebCT, and currently there are 6 undergraduate programs online, 10 graduate programs online, and 10 graduate certificate programs online are available online. Although the Web has become an important instructional delivery mechanism, many students and faculty still fear self-directed learning processes and worry about the quality of online courses. Application of appropriate online instructional strategies is suggested to help students master course contents and to improve the quality and effectiveness of online courses.

Purpose

The current study investigated short-term and long-term effects of two kinds of AOs in a fully Web-based course. A concept map was used as a visual organizer, and an outline was used as a text organizer. Students' knowledge acquisition and application were tested both immediately and four weeks after the instruction. All course

materials and assignments were accessed and completed on the Internet without any face-to-face instruction or meetings.

This study strengthens the connections between theory and educational practice by providing empirical evidence for the use of AOs in distance education based on cognitive learning theories.

Specifically, this study is designed to explore one instructional strategy, the use of AOs, to promote information literacy in a fully web-based distance course. Two hypotheses were posited for this study.

Null hypothesis I. There is no difference in the short-term knowledge-based and performance-based learning achievements among students in the concept map, outline and control groups.

Null hypothesis II. There is no difference in the long-term knowledge-based and performance-based learning achievements among students in the concept map, outline and control groups.

Foundations

Theoretical Foundation

The rationale for using advance organizers (AOs) is rooted in cognitive learning theories. Cognitive theories claim that learning depends on processing capacity and prior knowledge (Driscoll, 1999). With the aid of AOs, learners are able to link what they already know to new information and apply it to new context.

Ausubel (1968) first introduced the concept of AOs in his assimilation theory of meaningful learning and retention. Like other cognitive theorists, Ausubel asserted that learning is based on schemata or mental structures by which students organize their perceived environment. Ausubel suggested that AOs help students activate prior knowledge in the new instructional context and make the instructional process meaningful to the students (Ausubel, 2000). His early experiments provided the most-cited research supporting the effectiveness of AOs with increasing achievement (Ausubel, 1960; Ausubel & Fitzgerald, 1961, 1962; Ausubel & Youssef, 1963).

Mayer reinterpreted Ausubel's use of AOs in terms of his assimilation encoding theory (Mayer, 1979a). He indicated that the successful use of AOs is highly influenced by the availability of an assimilative context in memory and the active use of knowledge during learning. He reported the results of a series of nine studies and also examined 27 AOs studies conducted by other researchers in the 1960s and 1970s (Mayer, 1979a, 1979b). The results supported his contention that AOs will facilitate learning in situations where learners do not possess a rich set of relevant past experiences and can actively integrate the AOs in the new context.

Based on neurophysiological science, the recent brain-based learning research also supports the idea of meaningful learning and active processing. It is asserted that meaning is more important than information and active information processing is strongly connected to prior learning (Caine & Caine, 1991). The brain-based learning theories also imply that the teacher needs to prepare the students before a unit of study to attach new information to prior knowledge so the new information has something to "latch onto"(Jensen, 1996). In addition, empirical studies support many of the proposition regarding AOs and learning posed by various theories.

Empirical Evidence

Extensive research was conducted on the effectiveness of using AOs in classroom teaching from the 1960s to the 1990s. The research evidence concerning any facilitative effect of AOs upon learning and retention is variable, but positive in general. Although Ausubel's early experiments supported the effectiveness of AOs with significant increasing learning achievement (Ausubel, 1960; Ausubel & Fitzgerald, 1961, 1962; Ausubel & Youssef, 1963), later studies failed to show a consistent positive facilitative effect (Barnes & Clawson, 1975; Luiten, Ames, & Ackerson, 1980; Mayer, 1979b; Stone, 1983). The discrepancies regarding the effectiveness of AOs might result from inadequate construction of AOs or weak research procedures or control (Kenny, 1993; Luiten et al., 1980; Mayer, 1979b).

In the 1990s and 2000s, AOs still remained an actively debated topic. Research on the traditional AOs drastically decreased in number possibly due to the non-statistical-significance of the research results. However, many researchers began to conduct studies on AOs in a variety of formats, such as visual AOs (DaRos & Onwuegbuzie, 1999; Herron, Hanley, & Cole, 1995; Hirumi & Bowers, 1991; Millet, 2000) and multimedia AOs (Calandra, Lang, & Barron, 2002; Hale, 2003; Minchin Jr., 2004; Tseng, Wang, Lin, & Hung, 2002; Yeh & Lehman, 2001). Consistent with the historical findings, recent research again failed to generate statistically significant results on effectiveness of AOs on posttest scores between treatment groups and control groups, though most researchers continued to suggest a mild but positive effect of AOs on learning and retention.

The statistical non-significance of the research might be attributed to imprecise construction of organizers, short duration of treatment, inadequate research control, and insufficient instruction on how to use organizers (Kenny, 1993; Luiten et al., 1980; Mayer, 1979b). Synthesizing the findings of recent research on AOs, the current study is an attempt to:

1. investigate AOs as a helpful orienting device not only in the context of computer-assisted instruction, but also in the online learning environment.
2. test different types of AOs, including graphic, graphic + text, and multimedia instructional organizers.

Method

Subject

Participants of this study were selected from a population of undergraduate students enrolled in a fully Web-based health class at the University of Central Florida. This course was a health related ethics course. It was required for all health-related major undergraduate students. The course was fully Web-based, requiring no face-to-face meetings, where the instructor and students logged into a WebCT account and communicated through course pages, discussions and e-mails within the online account. The course covered ethical issues in health care, including life-saving measures, rights to die, transplants, surrogate parenthood, privacy and confidentiality, and decision-making.

The population encompassed 164 undergraduate students enrolled in a fully web-based class. The majority of the students were between the age of 21-23 in either their junior or senior year. Most students were health-related majors. Three fourths of the participants were female students, and most of the students are white Caucasians. All enrolled students were asked to participate in this study on a voluntary basis. Bonus points towards the course credit were awarded for participants who completed all instruments. Almost 80% of the class voluntarily participated in the study activities, and 63 of the 164 course participants completed both quizzes and a survey.

Research Design

This study used a repeated-measure, control-group posttest-only design with random assignment to examine the effects of advance organizers (AOs) on learning as illustrated in *Figure 1*.

R E_1	X_1 (Graphic Organizer)	O_1	O_2
R E_2	X_2 (Text Organizer)	O_3	O_4
R C	(No Advance Organizer)	O_5	O_6

Figure 1. Research Design Diagram

"R" indicated that all participants were randomly assigned to three groups, two treatment groups (E_1 and E_2) and one control group (C). AOs were the intervention in this experimental event. The experimental group (E_1) reviewed a concept map, a form of graphic organizer, before reading textbook. The comparison group (E_2) reviewed a text organizer, and the control group (C) did not read any AO before textbook reading. During the course of the study, all three groups completed an immediate posttest (O_1, O_3, and O_5) and a delayed posttest (O_2, O_4, and O_6).

Dependent & Independent Variables

The dependent variable in this study is students' learning achievement, encompassing their short-term (O_1, O_3, and O_5) and long-term knowledge acquisition and application (O_2, O_4, and O_6). The short-term and long-term knowledge acquisition was tested with two corresponding 12-item knowledge quizzes. The short-term knowledge application was tested with problem-based scenario essay questions.

The independent variable is the treatment of AOs (X_1 & X_2). The three groups had the same instruction, except for the treatment of AOs. The experimental group used a concept map (X_1); the comparison group used a textual outline (X_2); and the control group had no AOs exposure before textbook reading.

A posttest I-posttest II repeated-measure design was exploited in this study, and time was another independent variable for the research. It is assumed that the time factor might influence students' learning achievement over a period of four weeks' time.

Advance Organizers

Two forms of AOs were designed respectively for the experimental and comparison groups. The construction of the AOs was based on the criteria prescribed by Mayer (1979b) and followed a series of research-based procedures (Bricker, 1989; West, Farmer, & Wolff, 1991). Students were instructed to review the AOs before they read the textbook. *Figure 2* and *Figure 3* illustrate the AOs used in the study.

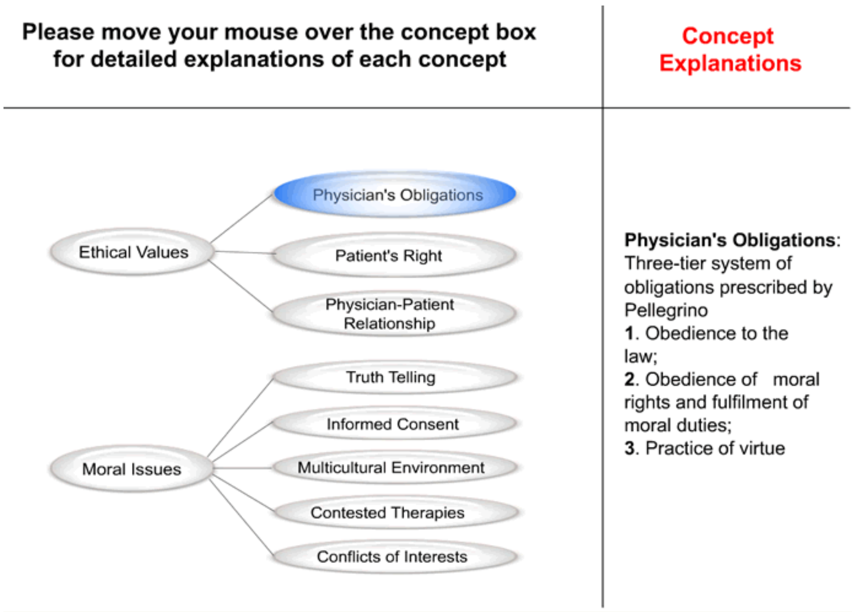
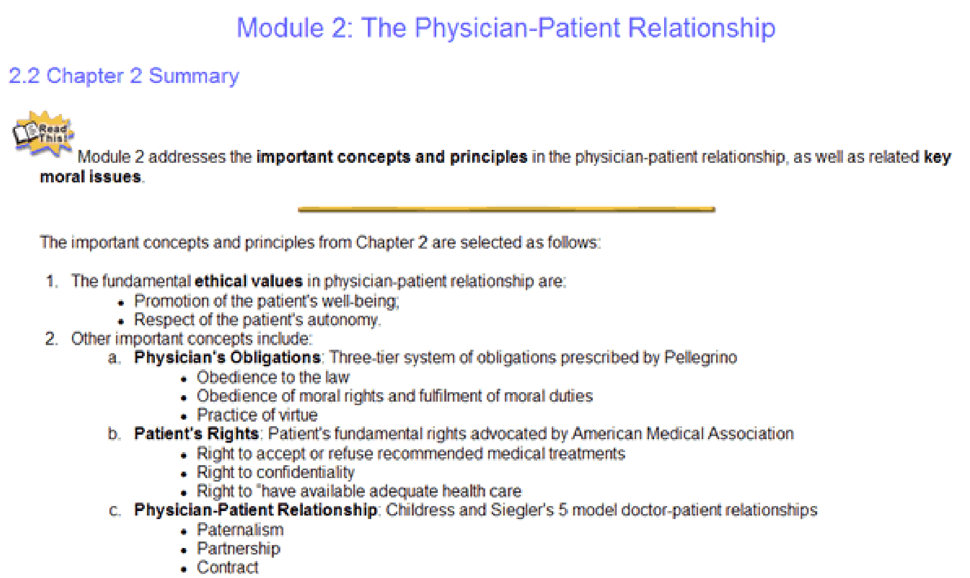


Figure 2. Graphic Organizer: Concept Map



Module 2: The Physician-Patient Relationship

2.2 Chapter 2 Summary

Read This!

Module 2 addresses the **important concepts and principles** in the physician-patient relationship, as well as related **key moral issues**.

The important concepts and principles from Chapter 2 are selected as follows:

1. The fundamental **ethical values** in physician-patient relationship are:
   - Promotion of the patient's well-being;
   - Respect of the patient's autonomy.
2. Other important concepts include:
   a. **Physician's Obligations**: Three-tier system of obligations prescribed by Pellegrino
      - Obedience to the law
      - Obedience of moral rights and fulfilment of moral duties
      - Practice of virtue
   b. **Patient's Rights**: Patient's fundamental rights advocated by American Medical Association
      - Right to accept or refuse recommended medical treatments
      - Right to confidentiality
      - Right to "have available adequate health care
   c. **Physician-Patient Relationship**: Childress and Siegler's 5 model doctor-patient relationships
      - Paternalism
      - Partnership
      - Contract

Figure 3. Text Organizer: Textual Outline

The graphic organizer is a flash-based interactive concept map as illustrated in Figure 2. The text organizer presents the same concepts and explanation as the concept map, as illustrated in Figure 3. Both AOs are linked to the instruction page of module 2. The only difference between the two organizers is the presentation of the relationship among the concepts. The concept map illustrates the relationship visually in a nonlinear way, and the textual outline presents it textually in a linear way. The validity of these AOs was tested and confirmed by expert review from both the instructor and the outside instructional designer, and modifications were made based on their suggestions.

Procedures

This study lasted for six weeks. During the first week of the spring semester, 2006, participants were randomly assigned into three groups. Each group was provided with one version of module 2 during week two. In the course module, the students were suggested to first review the advance organizers (AOs) to have an overall idea of the key concepts and issues covered in this module, if they had one available in their group. The students in the experimental group reviewed the multimedia concept map before reading the book. The students in the comparison

group reviewed the text outline before reading the book. The students in the control group were not given an AO, and they proceeded directly to textbook reading.

Chapter 2, "The Physician-Patient Relationship" of the textbook, Biomedical Ethics (Mappes & Degrazia, 2005), was the designated reading materials. After textbook reading, the students were instructed to complete all the assignments on the assignment page, including the two parts of the posttest I. The knowledge quiz of posttest I was a timed WebCT quiz. The students had 15 minutes to complete the 12 questions and they could only access and submit the quiz once. However, as this was a fully Web-based course, the quiz was not proctored and students had the flexibility to do the quiz at their convenience during the instruction week. For the second part of posttest II, the students completed three questions based on a scenario using Microsoft Word and submitted the assignment to the WebCT Dropbox tool by the next Monday morning. Also during this week, students filled out an online survey to report their background information and their uses of AOs.

Four weeks after module 2, in week six, posttest II was administered through WebCT. Together with all the other assignments for module 6, posttest II, including a quiz and three scenario questions, was open for the students. It was stated in module 6 that both the quiz and scenario questions of posttest II were part of the voluntary research. The students completed this posttest with the knowledge they had learned in module 2.

Research Findings

Statistics procedures, including descriptive analysis, one-way analysis of variance (ANOVA), and repeated-measure regression were performed to study the research findings.

Descriptive analysis was used for scores in the posttests. Means, standard deviations, and effect sizes of students' achievement scores were computed for each quiz and scenario questions of posttest I and II. The assumptions of the analysis, including the homogeneity of variance and the normality of population distributions, were examined using the Levene's test and the Q-Q plot procedures. Detailed descriptive statistics of the students' learning outcomes are illustrated in Table 1 and Table 3 in the next sections under the discussions of research hypotheses.

Null Hypothesis I: There is no difference in the short-term knowledge-based and performance-based learning achievements among students in the concept map, outline and control groups.

In posttest I, students of group 1 using a concept map had the highest mean score (36.25) in the knowledge quiz 1, compared with those of the other two groups. In the performance-based scenario questions, there was little difference in the mean scores of the three groups. Table 1 illustrates the detailed means and standard deviations of students' learning outcomes in posttest I.

Table 1 Means and Std. Deviations of Posttest I Scores

		Group				Full Score
		1	2	3	Total	
Quiz 1	Mean	36.25	32.67	33.89	34.15	60
	Std Deviation	9.59	11.46	10.60	10.64	
Scenario 1	Mean	22.55	22.87	22.28	22.55	25
	Std Deviation	2.43	2.33	2.25	2.33	

Note: Group 1—Experimental group with concept map; Group 2—Comparison group with outline; Group 3—Control group.

To test hypothesis I, ANOVA was used to compare the mean scores of posttest I of the three groups. Null hypothesis I suggests that students who were exposed to a concept map AO or an outline AO would show no difference, in both the short-term knowledge-based and performance-based learning achievements, from those who were not exposed to an AO. Table 2 shows that there is no statistically significant difference among the three groups in either the knowledge quiz ($F_{2, 122}$= 1.130, α>0.05) or the performance scenario questions ($F_{2, 137}$ = 0.412, α>0.05). Also, the effect sizes for AOs in both tests are relatively low. Only 1.8% of the differences in quiz 1 scores can be explained by the treatments of AO among the groups. Less than 1% of the difference in scenario 1 scores can be explained by the use of AO.

Table 2 Tests of Between-Subject Effects in Posttest I

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Quiz 1	255.452	2	127.726	1.130	.327	.018
Scenario 1	63.326	2	31.663	.412	.664	.009

Null Hypothesis II: There is no difference in the long-term knowledge-based and performance-based learning achievements among students in the concept map, outline and control groups.

In posttest II, there are little variations in the mean scores in either quiz 2 or scenario 2 questions. The control group outscored the AO treatment groups by less than 1 point in both tests. Table 3 shows the means and standard deviations of the students' learning outcomes in the delayed posttest.

Table 3 Means and Std. Deviations of Posttest I Scores

		Group				Full Score
		1	2	3	Total	
Quiz 2	Mean	29.04	30.95	30.76	30.36	60
	Std Deviation	11.32	6.86	8.40	8.71	
Scenario 2	Mean	23.29	22.23	24.10	23.17	25
	Std Deviation	3. 62	5.57	2.77	4. 21	

Note: Group 1—Experimental group with concept map; Group 2—Comparison group with outline; Group 3—Control group.

Similar to the findings in the short-term learning achievement posttest I, the difference in posttest II is not statistically significant in either the knowledge-based quiz ($F_{2, 95}$= 0.412, α>0.05) or the performance-based scenario questions ($F_{2, 60}$= 1.051, α>0.05). The effect size of AO in quiz 2 is below 1%. The effect size of AO in scenario questions 2 is 3.4%, far below 20% which is indicative of a small effect by the Cohen's convention.

Table 4 Tests of Between-Subject Effects in Posttest II

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Quiz 2	63.326	2	31.663	.412	.664	.009
Scenario 2	37.13	2	18.565	1.051	.356	.034

Additional Analyses

During the study, students were given the opportunity to fill out a survey about their online learning experience, especially their attitudes towards using AOs. 130 students from the three groups completed this survey. Table 5 shows the students' experience using AOs in the treatment groups. Approximately half of the respondents in the concept map group indicated that they spent 6-10 minutes reading the concept map, and they read it twice. Approximately half of the respondents in the outline group reported that they spent 1-5 minutes reading the text outline, and they read it once. The majority of the respondents in both groups agreed that using advance organizers was helpful for them.

Table 5 Survey on Students' Experience with Using AOs

	Concept Map			Text Outline		
	Mean	%	N	Mean	%	N
Time spent on AO	6-10 min	42.1%	16	1-5 min	44.2%	19
How many times read AO	Twice	57.9%	22	Once	41.9%	18
When read	Before textbook	44.7%	17	Before textbook	51.2%	22
Usefulness	Agree	86.8%	33	Agree	69%	29
Total			38			42

Discussions

Neither of the null hypotheses failed to be rejected in this study on using advance organizers (AOs) in Web-based distance education. The research findings indicate that there is no difference in either the short-term or long-term learning achievements among students in the concept map, outline and control groups.

According to Ausubel's assimilation theory, students given AOs should perform better on tests on the material-to-be-learned than students in control groups (Ausubel, 1968). In the current study, students in the concept-map group outscored the other groups by 3-4 points out of a full 60 points by average in the immediate knowledge quiz (posttest I). The difference in performance-based scenario questions was slight among the three groups. The full score for the scenario questions was 25, and the mean scores for all of the groups were around 22.5, indicating a ceiling effect that the assessment instrument may lack sensitivity and discrimination in measuring learning outcomes. The control group scored at an average of 22.28 out of 25 on the scenario questions. There was

less than 3 points (12%) of improvements for the treatment groups to achieve. Similar to the historical studies on AOs in face-to-face classes, no statistically significant difference was found in either the knowledge-based or the performance-based tests in this Web-based AO study.

It is speculated that the AO effect should be greater in longer studies, especially in the ones over 10 days, than in shorter ones (Ausubel, 1968; Luiten et al., 1980; Stone, 1983). However, this study failed to prove a greater AO effect on students' learning achievements in a delayed posttest (posttest II) four weeks after the AO intervention. The differences in both the knowledge-based and the performance-based tests were slight, and the effect sizes were considered to be small and below 0.05 by the Cohen's convention. Similar to posttest I, a lack of differentiation might be one of the reasons that attribute to the non-significant result in posttest II. Also, in the posttest, students reported a shortage of time during the quiz, and over 50% of the students made errors in the last two quiz questions. Therefore, speeding effect might be another factor that seriously affect the measuring error of the quiz instrument.

In combination with the AO effects, this study examined other factors that might influence students' learning achievements using repeated-measure analysis of covariance (ANCOVA). The results show two statistically significant factors: time between posttests and weekly study time. There is a statistically significant time effect ($F_{1,89}=13.185$, $p<.01$) on students' learning outcome. Almost 13% of the variance in scores can be explained by the time elapsed between the two posttests. This indicates that students' test scores were considerably lower in the delayed posttest II compared with the immediate posttest I, with an elapse of four weeks' time. Also, weekly study time has a statistically significant effect on students' learning achievement ($F_{1,42}=6.165$, $p<.05$). Almost 13% of the variance in scores can be explained by the weekly study time. This suggests that the more time students had reported as learning time, the better they would perform in the posttests. Other factors were examined without statistical significant effect. They are GPA scores, technical abilities, pretest scores, Web-based learning experience, age, and class standing.

Most of the students found using AOs, especially the concept map, helped them scaffold the learning materials. Their feedbacks in the survey indicated how they used AOs in learning. The majority of the students would read AOs before they read the textbook. They spent, on average, 6-10 minutes reading the concept map, and would usually refer back to the concept map during or after they read the textbook. For the text outline, the student would spend 1-5 minutes reading, and read it only once. According to the survey results, this study successfully demonstrated how AOs could be integrated in Web-based distance learning, and the concept map was better received by the students compared with the text outline.

Conclusions

Web-based distance learning is becoming an important trend in the higher educational settings. More and more instructors and students choose online classes to take advantage of the time and location convenience. It has always been a challenge to examine the effects of pedagogical strategies in a fully Web-based environment. The current study investigated the use of advance organizers (AOs) in a fully Web-based health care ethics course. Consistent with results of the studies in the traditional classes, this study failed to show a statistically significant short-term or long-term effect of AOs on knowledge-based or performance-based learning achievements. Also, this study failed to determine which format of AOs (graphic or text) better facilitate students' learning achievement. However, students showed positive attitudes towards using AOs in online learning and they reported that the use of AO helped them break down the course contents and highlighted the important concepts.

The failure to generate a statistical significance might be due to several reasons. One of the issues that the researcher had found in the study is that it is impossible for an online quiz to be monitored. Though the quizzes had been instructed as close-book tests, it was possible that students still referred to their lecture notes and the textbook while they answered the quizzes. This might seriously weaken the validity of the quiz instruments. An important implication for further research is to develop measures to prevent students from referring to other assistant materials in self-directed online quizzes. Another reason for the non-significant result might be the lack of discrimination of the scenario questions in measuring students' analytical and critical thinking abilities. Future studies need to develop more strict rubrics to differentiate students' learning outcomes in the assessment instruments. Also, the limited intervention length might be an important factor that influences the effectiveness of AO. The current AO intervention was used in a one-week module. For future studies, it might lead to statistically significant results if the AO strategy is integrated in a whole semester-long course and the AO effect is tested on a course level.

This research shows that instructional strategies, like advance organizers, can be incorporated into online learning experience. It has been assumed by many researchers that the adoption of effective online teaching and learning strategies is a solution to learning challenges in an interactive multimedia environment. This investigation can be served as an example for future studies on how to design, implement, evaluate, and disseminate empirical research result on the effectiveness of instructional strategies in Web-based distance education.

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Different Levels of Learning Achievement in a Web-based Environment with Animation

Yu-hui Ching
Yu-chang Hsu
Huifen Lin
Francis Dwyer

Abstract

This study examines four levels of learning outcomes of 204 undergraduates in learning environments featured two navigation modes (i.e. linear and nonlinear) and three instruction presentation modes (i.e., text, text with static graphics, and text with animation). The results indicated that students performed significantly better with the help of visuals in lower-level assessments regardless of navigation modes. The implication for instructional design will be discussed and presented.

Introduction

Designing effective online instructions has gained increasing attention nowadays because of the ubiquity of the Internet that leads to the popularity of online learning and distance education. Since most of the online instruction and learning materials are delivered through websites, the design principles of websites should be considered while designing online learning materials. As suggested by Nielsen (2000), typical principles governing website design include navigation, response time, credibility, and content. Among these principles, navigation mode is one important feature to be considered especially in designing instructional websites because it affects the instructional sequence learners follow and the degree of control that learners have over their learning (Lawless & Brown, 1997). To date, a great amount of navigation studies were conducted to understand the browsing behaviors of website users; however, only a handful studies have investigated its effect on student learning achievement at different levels.

Taking advantages of the advanced computer technology and the broadband network, web-based instruction can now afford to incorporate multimedia designing to enhance learning in terms of the accessibility. The use of static visuals and animation in web-based instruction is one example of the aforementioned development. As an instructional strategy that provides attractive and explicable visual assistance, animation is deemed to be capable of arousing learners' interests and facilitating learners to comprehend the concept (Rieber, 1994). In the past two decades, respectable efforts have been devoted to studies examining the effectiveness of animation. However, there were no consistent results. Some have reported positive effects of animation (Beck & Layne, 1988; ChanLin, 2004; Park & Gittelman, 1992; Rieber, 1990b; Rieber, Boyce, Assad, 1990), while others have revealed no significant differences between animation and static visuals (Lin & Dwyer, 2004; Reed, 1985; Rieber 1989). One reason to explain the inconsistency is that studies measure learning outcomes at different levels from factual knowledge to problem-solving skills. It is necessary to differentiate the effectiveness of animation in helping different levels of learning.

Theoretical Framework

Navigation

Lawless and Brown (1997) argued that multimedia learning environment allows learners control over the information they access and their learning sequences, which helps create meaningful learning. Hsu (2006) also indicated that nonlinear capability of the WWW has great potential in education for the similar reasons. However, nonlinearity also could lead to disorientation, which poses the potential negative impact on learning since some learners might be overloaded with information while lacking a clear "roadmap" to

proceed with learning (McDonald & Stevenson, 1998). Regardless the disorientation problems, researchers (Jacobson & Spiro, 1995) posited that learners with navigational choices did better in transferring their knowledge to a new situation.

Animation

In educational research, animation generally serves one of the following functions: attention-gaining, presentation, and practice (Rieber, 1990a). As for its presentation function, animation can be designed to represent domain knowledge and explain complex phenomena (Park & Gittleman, 1992). The cognitive theory that guides the instructional use of animation is Paivio's (1990) dual coding theory. This theory suggests two different processing systems in human cognition, one verbal and the other nonverbal. It further argues that words and pictures are encoded separately in these two aforementioned systems. Accordingly, from a perspective of information processing, animated visuals helps increase the chances for information being processed and retrieved.

In addition to the theoretical basis, like the static visuals, animation should also be placed where there is a "need for external visualization" in order for visuals to aid the learning successfully (Rieber, 1994). Meanwhile, motion and trajectory are deemed to be the attributes possessed by animation that distinguish its capability from static graphics (Riber, 1994; Weiss, Knowlton & Morrison, 2002). That is, in order for animation to be more effective than static ones, the subject to be learned should involve either the motion or the trajectory of an object, or both. Without the need for motion and trajectory, the advantage of animation as an instructional strategy will not be shown.

Research Purpose and Hypothesis

This study aims to examine two factors, navigation mode and presentation mode of instruction, in a web-based multimedia environment. Specifically, there were three purposes of this study. First, the effect of navigation mode (i.e., linear and nonlinear) on learning achievement of different levels was investigated. It was hypothesized that learners would have better achievement in a nonlinear learning environment because learners would have more control over their learning sequences. Second, presentation mode of instruction (i.e., text, text with static graphics, and text with animation) on different levels of learning achievement was examined. It was hypothesized that learners with the support of animation would learn significantly better than learners without the support of animation, hence better performance on all the criterion measures. Third, this study intended to investigate if a significant interaction existed between navigation modes and presentation modes.

Methodology

Participants

Two hundred and four undergraduate students from an introductory statistical class in a large northeastern university were recruited to participate in this study. There were 78 males and 126 females among the participants, with the mean age of 19.62 (*SD*=1.59). Participation was volunteered-based and additional class credits were given to the students who participated in this study by the instructor.

Instructional Material and Criterion Measurements

Developed by Dwyer (1978), the core instructional unit employed in this study contains approximately 2000 words about the anatomy and functions of the human heart, including the parts of the human heart, circulation of blood flow, and blood pressure. This instructional material comes with five criterion measures: comprehension, drawing, identification, terminology, and total. A brief description of each criterion measure follows:

Drawing Test (KR- 20= .93). The objective of the drawing test was to evaluate student ability to construct and/or reproduce items in their appropriate context. The drawing test provided the students with a numbered list of terms corresponding to the parts of the heart discussed in the instructional presentation. The students were required to draw a representative diagram of the heart and place the numbers of the

listed parts in their respective positions. For this test, the emphasis was on the correct positioning of the verbal symbols with respect to one another and regarding their concrete referents.

Identification Test (KR- 20= .87). The objective of the identification test was to evaluate student ability to identify parts or positions of an object. This multiple-choice test required students to identify the numbered parts on a detailed drawing of a heart. Each part of the heart, which had been discussed in the presentation, was numbered on a drawing. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.

Terminology Test (KR- 20= .87). This test consisted of items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas associated with an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles.

Comprehension Test (KR- 20= .84). Given the location of certain parts of the heart at a particular moment of its functioning, the student was asked to determine the position of other specified parts of the heart at the same time. This test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding in which the individual can use the received information to explain some other phenomenon.

Total Test Score (KR- 20= .96). The items contained in the individual criterion tests were combined into a composite test measuring global achievement obtained from the instructional unit.

Research Design

A 2X3 posttest experimental design is used to seek answers to the aforementioned research questions. Figure 1 presented a graphic illustration of this experimental design. Participants were randomly assigned to one of the six treatment groups shown in the figure.

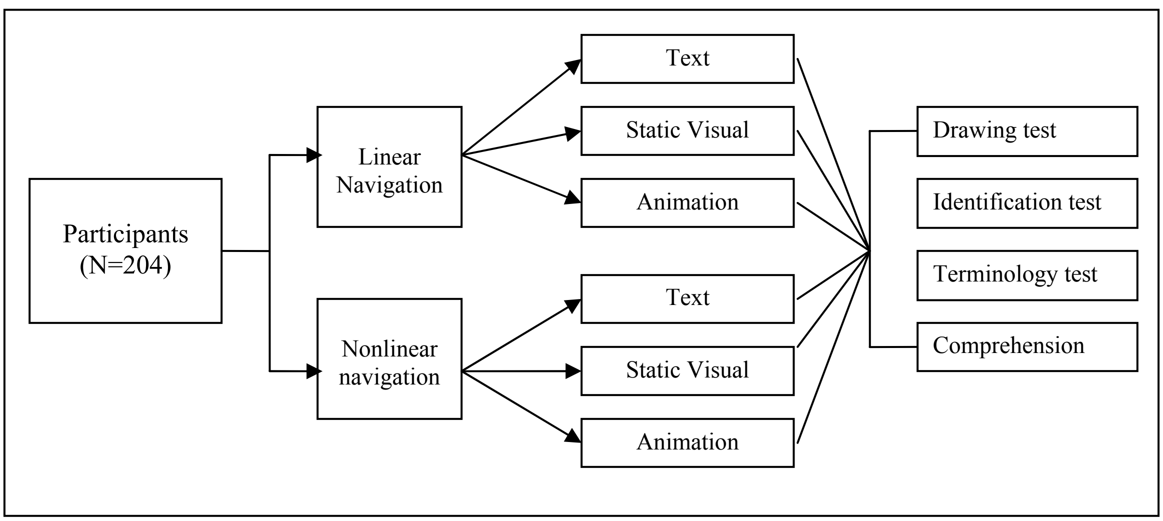

Figure1. A posttest-only 2 X 3 factorial design

Treatment Material

Linear navigation. In this treatment, students utilized only “BACK” and “NEXT” buttons at the bottom of the text on each frame to navigate. The menu on the left was provided as an anchor without any navigation function. Figure 2 is one of the screenshots of the linear-navigation website.

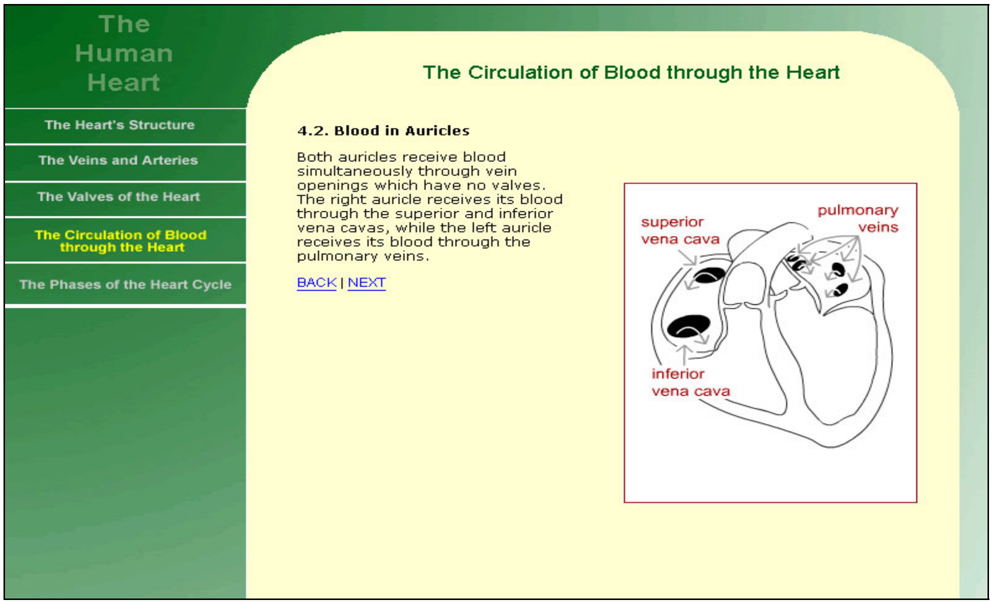

Figure 2. Screenshot of a linear navigational frame.

Nonlinear navigation. In this treatment, instead of the "BACK" and "NEXT" buttons, the navigation menu with two levels - the "Unit" level and the "Lesson" level, was provided on the left side of the frame (See Figure 3). Lessons embedded in each unit were displayed on-demand using a mouse over technique (See Figure 4). While clicking on the drop-down menu displaying lessons, students could move directly to any lessons. This learner control was provided consistently on every webpage of this module. Thus, students could learn the materials according to the sequence they prefer.

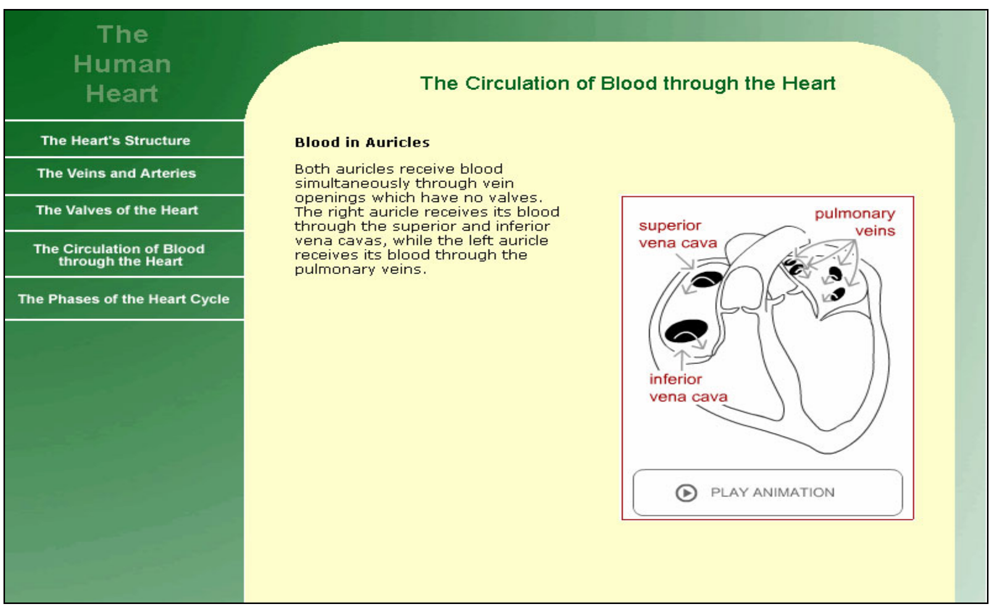

Figure 1. Screenshot of a nonlinear navigational frame without drop-down menu.

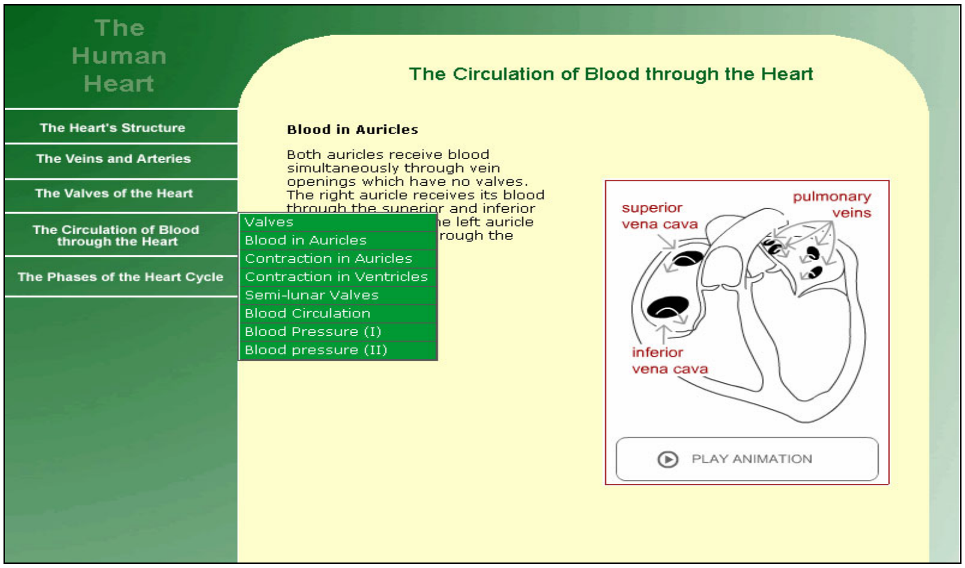

Figure 4. Screenshot of a non-linear navigational frame with drop-down menu.

Text. Students only learn from the text demonstrated on 20 frames with no visual aids.

Static Graphics. A static graphic was provided on each frame along with the text (the same as what provided in the "text" treatment) to facilitate students to visualize the different parts and functions of the human heart. Colors and arrows were used for highlighting and for the direction of motion (see Figure 2)

Animation. In this treatment, in addition to the text, and static graphics, animation was provided on 15 frames to enhance students' understanding of the materials. Given that the function of the human heart is viewed as a complex system, animation was used to help learners visualize how the system works and improve their conceptual understandings of this system (Weiss et al. 2002). Considering the fidelity of animation, following the suggestions of Weiss et al. (2002), abstract animation, instead of concrete one was designed to help learners better retain information.

Various animation techniques were used independently or in combination to provide dynamic illustrations of concepts that were difficult to comprehend. Some examples are progressive reveal, motion, pop-in verbal, contraction, and expansion. Students were allowed to review the animated visuals as many times as needed by clicking on the "PLAY ANIMATION" button (see Figure 3).

Data Analysis

Two one-way ANOVA was first used to analyze the data with each of the two independent variables, navigation mode, and presentation mode of instruction. The dependent variables were four criterion measures and the total of the four tests. Then a two-way ANOVA was conducted to examine the interaction effects between two independent variables on the four tests and the composite scores.

Results

Results of the ANOVA indicated that the navigation mode did not have a significant main effect for all the criterion tests: drawing test $F(1, 202) = .999$, $p = .319$; identification test: $F(1,202) = 1.738$, $p = .189$; terminology test: $F(1, 202) = .089$, $p = .766$; comprehensive test: $F(1,202) = .264$, $p = .608$; total score: $F(1, 202) = .799$, $p = .372$. Table 1 presents the means and standard deviations for this factor on each criterion test.

Table 1. Mean and Standard Deviation of Each Criterion Test for Linear and Nonlinear Treatment Groups

Navigation	N	Criterion Measures [a]				
		Drawing	Identification	Terminology	Comprehension	Total
Linear	102	9.87 (5.88) [b]	13.34(4.97)	11.88(5.01)	10.14(4.64)	45.24(18.48)
Nonlinear	102	10.75(6.57)	14.26(5.02)	12.09(4.84)	10.45(4.06)	47.55(18.48)

[a] The maximum score for each criterion measure is 20.
[b] Value in parentheses indicated standard deviation.

Results of the ANOVA indicated that presentation mode of instruction has a significant main effect on students' scores for drawing test (F (2, 201) =24.064, *p*=.000), identification test (F(2, 201) =11.458, *p*=.000) and total score (F(2, 201) =10.305, *p*=.000). The effect of presentation mode was approaching significance on students' scores for terminology test (F(2, 201) =2.827, *p*=.062). However, this main effect was not found significant on students' scores for the comprehension test (F(2, 201) =1.694, *p*=.186). Table 2 summarized the descriptive statistics of this main effect on scores for each criterion test. Since the omnibus tests are significant in drawing test, identification test and total score, Scheffe's test has been used for the post hoc comparisons. The results of the post hoc comparisons showed that students who received either animation or static visuals performed significantly better than did those who only received text for the drawing test, identification test and total score. However, animation did not have a significantly better effect than did static visuals in all three previously mentioned tests.

Table 2. Mean and Standard Deviation of Each Criterion Test for Text, Static Visuals, and Animation Groups

PKG	N	Criterion Measures [a]				
		Drawing	Identification	Terminology	Comprehension	Total
Text	68	6.47(4.85)	11.60(5.07)	10.93(4.65)	9.68(4.58)	38.68(17.16)
Static Visuals [c]	68	11.82(6.10)[b]	14.47(4.78)	12.13(4.92)	10.18(3.74)	48.60(17.72)
Animation	68	12.63(5.86)	15.34(4.42)	12.90(5.04)	11.03(4.63)	51.90(18.15)

[a] The maximum score for each criterion measure is 20.
[b] Value in parentheses indicated standard deviation.
[c] both Static Visuals and Animation Groups also receive the same text as that received in the Text Groups

A 2X3 ANOVA was conducted to examine the interaction effects between navigation mode and presentation mode. No significant interaction was found between navigation mode and presentation mode for all four criterion tests and the total score. Table 3 provided the means and standard deviation of each criterion test for all the treatment groups. (drawing test F (2, 198)=.515, p=.598; identification test, F (2,198) =.029, p=.972; terminology test, F(2, 198)=.007, p=.993; comprehension test, F (2, 198) =.529, p=.590; total score, F (2, 198)=.161, p=.851).

Table 3. The Relationships of Navigation Mode and Presentation Mode on the Criterion Measures

	Linear			Nonlinear		
	Text [a]	Static Visuals	Animation	Text	Static Visuals	Animation
Drawing	6.26 (6.05) [b]	10.82	12.53(4.47)	6.68	12.82(6.40)	12.74(5.60)
Identification	11.03(4.69)	14.06	14.94(3.52)	12.18	14.88(4.45)	15.74(3.84)
Terminology	10.88(4.97)	12.00	12.76(3.52)	10.97	12.26(5.08)	13.03(4.11)
Comprehension	9.65(5.41)	9.59	11.18(3.65)	9.71	10.76(3.24)	10.88(3.68)
Total Score	37.82(18.64)	46.47	51.41(13.97)	39.53	50.74(17.51)	52.38(15.44)

[a] N=34 for each cells.
[b] Value in parentheses indicated standard deviation.

Discussion and Conclusion

The results of this study showed that navigation mode did not have a significant effect on student learning achievement across different levels of learning. Students receiving nonlinear instruction performed similarly to other students assigned to the linear treatment. A possible explanation is that learners in the nonlinear environment might have interacted with the learning materials in a linear fashion by following the same order imposed by the drop-down menu, indicating that they could not take the advantage of learner control. It should be noted that the drop-down menu provided in the nonlinear environment was designed to allow students to access a certain topic by just one click. This design should empower learners to explore the materials in the order they prefer, and to revisit certain materials with great convenience as they see necessary. However, since the drop-down menu was organized with the sequence of the learning materials, should learners not take the advantage to navigate with the sequence of their own choice, they would end up reading the materials in the same order as would those students in the linear environment. This explanation echoed the previous research findings that, even in a nonlinear environment, learners generally relied on the structure of the navigation choices to guide their navigation behavior (Lawless & Brown, 1997). For future studies investigating how navigation behaviors affect learning, we would suggest that the navigation menu be designed in a way not implying the sequence of learning materials so learners are more likely to navigate at their own preferred sequence.

Presentation mode of the instruction (ie., text, text with static graphics and text with animation) had effects on the two tests assessing lower-level achievement, but did not have effects on the two higher-level ones. Further examination of this effect on the two lower-order tests showed that learners with the aids of both animation and static visuals outperformed learners learning only from text on two lower-level tests, with no difference between animation and static visuals. In short, students in animation group did not outperform those in the text group in the higher- order learning, neither did it outperform static graphics in all four criterion measures. Why did animation fail to help learners learn a complex system involving movements? According to the Apprehension Principle (Tversky, Morrison & Betrancourt, 2002), learners might have problems in perceiving and comprehending the provided animation. That is, given that the learning material is about the complex system of human heart, even though the animation had presented the simultaneous movements of different parts in the heart, learners might not be able to perceive the dynamics comprehensively and correctly and further comprehend how the complex system works due to the limitation of human cognitive capacity. Following this line of thinking, we would suggest that learners first perceive each step in the movement correctly then they are at the better position in comprehending the entire system. Static visuals portraying movement chunked into discrete steps may help learners perceive the subcomponents and how they work correct (Tversky et al., 2002). Then, the dynamics in the systems could be presented to the learners using animation. Viewing the animation at this time could help learners link the discrete steps together and test their understanding of how the system works.

Limitations

This study did not record the learners' navigation behaviors for analysis. To better understand the sequence that learners proceed with the learning materials and analyzing its impact on their learning achievement, the navigation behaviors are suggested be recorded and examined in the future study.

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The Use of Performance Technology in Creating a National Model High School Manuscript

Anthony S. Chow
The University of North Carolina at Greensboro

Abstract

This study tells the story of the Central Educational Center (CEC), a charter technical high school in Newnan, GA, that represents an attempt by Joe Harless to apply his industry validated performance technology ABCD system to some of the problems facing public education. Now in its 7^{th} year of operation, the school has received both local and national recognition as a model for educational reform both in terms of technical education and a place where the application of educational best practices in general is taking place. CEC, through its performance-based technically oriented, yet demanding courses, has been linked to significant drops in county-wide drop-out rates (as high as a 60% reduction), increases in academic test scores (graduation tests and SAT scores), and significant positive economic impact to the local community (over $75 million). Major stakeholders report high levels of satisfaction on a longitudinal basis although CEC faculty report some difficulty in adjusting to their changing roles as CEC responds to the evolving course demands of students and industry. 27 CEC students, stratified across three academic performance groups (high, medium, and low) were followed from their 10^{th} grade to 12^{th} grade years and compared to a control group of students across demographic variables, GPA, and instances of unexcused absences and tardiness. The data showed no improvement in academic performance as measured by GPA for either the CEC or control group but an independent samples t-test showed a statistically significant effect for instances of tardiness, $t(52) = -2.71$, $p < .001$, with the CEC group having a substantially lower number of instances of tardiness than the control group at the 12^{th} grade level. In addition there was a moderately negative relationship between performance level and instances of unexcused tardiness at the 12^{th} grade level, $r(25)= -.44$, $p<.01$, suggesting that low and medium performing students decreased instances of unexcused tardiness from 10^{th} to 12^{th} grade while their counterparts in the control did not. Both qualitative and quantitative methods were used to conduct this study and the results strongly suggest a meaningful role for the application of system's principles in public education exists.

Introduction

"If it is arrogant to offer different paradigms for what and how our educational system teaches our young, I can only state my reasons for such immodest behavior. I have spent my entire professional life researching, developing, and teaching the methodologies for influencing people – especially in the domain of influencing their knowledge and skills" (Joe Harless, 1998, p. 4)

This is a story worth telling. Imagine if you took one of the world's foremost experts in human performance, provided him with generous resources along with strong community and government support, and asked him to build a utopian, model school from the ground up. The human performance technologist is Joe Harless, considered the founder of front end analysis (FEA) and one of the forefather's of the field itself, and the school opened its doors in 2000 in a small Georgia community with tremendous fanfare and promise. Now six years later and, after garnering a prestigious National Model High School in 2004 from the Bill and Melinda Gates Foundation and being deemed the Georgia model for statewide educational reform, the impact and results of what Harless calls his "grand experiment" are examined in this study drawing from five years of research data.

Upon retiring after 30 years as a human performance technologist, Dr. Harless finally was able to do what he had always wanted to do when he first started his career – use performance technology to help improve public education. Some of the highlights of Dr. Harless's career included helping eradicate smallpox worldwide with the US Center for Disease Control, preventing additional nuclear meltdowns after the Three Mile Island incident, the design and development of the Boeing 777 jetliner, designing the training systems for the US Coast Guard, and much of the design and development system used by Microsoft today. In his book *The Eden Conspiracy: Educating for Accomplished Citizenship* (1998), Harless painted a vivid utopian educational vision utilizing his performance technology model called the Accomplishment Based Curriculum Development system or ABCD. This grand vision

saw an active "conspiracy joined by the entire community to prepare the young for accomplished citizenship" (Harless, 1998, pg. 24). In this conspiracy, the desired educational goals would reflect tangible student accomplishments where, outside of coverage of a specific set of subject matter-based curriculum or general preparation for future work life, students would be prepared to enter society as active, contributing members as envisioned by the local community. This school would, furthermore, represent a "grand experiment" for how the application of system's principles would look when brought to bear in public education.

Harless was on the last chapter of his book in 1996 when the Coweta County Superintendent of Schools approached him about a fundamental problem, echoed similarly by districts across the country, with the local school system: local businesses and employers were complaining that high school graduates were not meeting minimum employment needs. Dr. Harless told the Superintendent that at the heart of human performance technology is a customer-driven focus where what the customer should be able to do is first clearly identified and then, by working backwards, the appropriate performance system is built around helping customers achieve the desired behavior as efficiently and effectively as possible. He told the superintendent that the first step in the process would be to ensure that the effort to address issues around employable skills of high school graduates must be those that are having the problem and need to identify what skills are required in the first place: businesses.

Following the principles of his performance technology model, the first step in the design of this ideal school was a front-end analysis, in this case a needs assessment of local businesses that identified the tangible accomplishments employers expected from newly hired employees. These accomplishments then served as the focal point for building a public charter school that was closely aligned with a curriculum designed specifically to provide students with the knowledge, behaviors, and skills necessary to achieve these accomplishments.

Understanding the Context of Nationwide Educational Reform

What is occurring at CEC represents a local attempt at improving the quality of education but takes place in a much larger national context. Public outcries for the need to improve public education have been a prominent, consistent aspect since first implemented in the United States during the mid-1800's (Ravitch, 2000). Successful reform efforts, however, have been few and far between. Contemporary educational reform efforts still largely derive their roots from the 1983 National Commission on Excellence in Education's report *A Nation at Risk: the Imperative for Education Reform*, which called for a national educational reform movement to meet our "tide of mediocrity." During the original commission's comprehensive 18 month study involving the nation's public and private schools, the commission found that U.S. student performance was alarmingly low across a number of different measures. The report found approximately 23 million American adults were functionally illiterate and that among America's 17 year olds 13% were functionally illiterate while for minority youth this rate was as high as 40%. SAT scores had also steadily declined (by 50 points verbal, 40 points math) since 1967. Business and military leaders were complaining that America's youth did not have the basic skills expected costing them millions of dollars in remedial programs (*A Nation at Risk,* 1983). The results were even more disturbing given the report's assertion that the U.S. was not adequately preparing its nation's youth for the highly skilled labor force needed to compete with other industrialized nations (*A Nation at Risk*, 1983). Finally, in an international comparison of 19 tests with other industrialized nations, U.S. students were last seven times.

Although some researchers have claimed that the perceived problems in education identified in the mid-1980's were in many ways a myth manufactured largely by the conservative Reagan and Bush administrations (Berliner & Biddle, 1996; Bracey, 1996), it is clear that the primary areas of disagreement lie with how to interpret the general student performance measures and how we compare internationally. What both sides do agree on, however, is that there is a real decline in American education and, although at times over exaggerated especially during international comparisons through the powerful constituencies and entrenched bureaucracies within public education that do not favor major changes, there are indeed legitimate problems with schools where too many students are performing poorly and that many discussions on the failure of schools serve as proxies for much more complex larger societal issues that are largely beyond the scope of educational by itself (Berliner & Biddle, 1996; Stedman, 1996; Waters, 1998). In a 1996 report by the Sandia National Lab, it was concluded that viewing American education strictly as an aggregate measure is not precise enough and that the "fine structure" of the nation's aggregate data pointed to significant dropout problems among minority youth and students in urban schools (70% of black students and 50% of Hispanic students graduated on time compared to 80% of white students) and an in lower minority standardized test scores than whites students (black students averaged nearly 20 points lower

while Hispanic and Native Americans scores were lower by more than 100 points). Interestingly enough, a review of workforce data showed “very few companies point to inadequate academic preparation for new employees but rather focus on social "skills" such as punctuality and personal appearance” (Husselkamp, Carson, and Woodall, 2000, pg. 46)

In 1998, a panel of national educational experts came together to examine the progress the nation had made 15 years after the *Nation At Risk* report had been written. What the attendees found was that little or no academic progress has been made in the 23 years after the 1983 *A Nation at Risk* report. Since 1983, over 10 million students had managed to reach 12th grade still functionally illiterate while over 6 million students had dropped out entirely. For minority groups the results were even worse – in 1996 13% of black youth aged 16-24 were not in school and did not hold a high school diploma; 17% of first generation Hispanic youth had dropped out of high school and 44% of all Hispanic immigrant youth also dropped out of high school (Fordham Foundation, 1999). Their findings entitled *A Nation Still at Risk* concluded that “a dual school system had been created” where the gap between good and bad schools had widened. Educational access to high quality education was labeled the next civil rights movement (*A Nation Still at Risk*, 1999). The report stated, “The United States is the only country in the world in which children fall further behind the longer they stay in school” (*A Nation Still at Risk,* 1999, pg. 3). The report recommended that schools focus on three primary factors: *standards*, *assessment*, and *accountability* with a specific emphasis on pluralism, competition, and school choice.

A Call for a More Holistic, Systems Oriented Approach

How come so much effort and so little return on investment? There has been a rallying cry by many that the multitudes of “waves” of reform that have been tried over the past two decades represent “piecemeal” change and meaningful, widespread reform cannot occur unless systemic changes are made (Meier, 1998; Reigeluth, 1993; Betts, 1991; Hawley, et al, 1988). Harless’s *The Eden Conspiracy* (1998) and the subsequent opening of the Central Educational Center based on its tenets, represents the systemic approach called for by many educational reformers and utilizes the existing flexibility and autonomy presented by a contemporary, extremely popular educational reform initiative - charter schools. In addition, Harless’s reform effort represents a unique opportunity to observe the impact of system’s principles using the entire ADDIE system’s process (Analysis, Design, Development, Implementation, and Evaluation) from start to finish on a public school and its impact on overall student achievement. One of the central problems with education Harless reasons is not HOW we are teaching but rather WHAT we are teaching. He suggests that we develop schools and curricula based on desired accomplishments students should be able to perform rather than a set of separate content areas deemed to be intellectually appropriate for an educated, democratic population. He emphasized the need to make education relevant for students.

Research Questions and Rationale

The rationale for the need to study and understand CEC is strong. This study attempts to determine the overall integrity in which the CEC implementation follows system’s principles and what the impact the use of system’s principles and human performance technology has had within the context of the school, school district, and overall student performance. In addition, if CEC is found to be a valid, successful instance of the application of system’s principles in public education, how would we go about replicating it successfully outside of Newnan, GA and without someone of Joe Harless’s experience to help design and implement it? Specifically, this study has explored and sought to answer two major research questions: *What have been the results of using a system’s approach to design, develop, and implement the Central Educational Center? And, what impact has CEC had on student performance during its initial five years of operation?*

Research question two looks specifically at student performance during CEC’s first five years. This question looks closely at how student performance is measured at CEC within the larger context of school performance. What are the overall goals of CEC, what indicators have been identified to measure these goals, and what instruments and data are collected to measure these indicators? The accurate measure of performance is always of critical importance and, as CEC continues to garner state and nationwide acclaim, the need to ensure that the indicators of success being used by the school are accurate, valid, and reliable have become increasingly important. Most critically is to ensure that the existing performance and anecdotal data that have earned CEC much acclaim and national recognition is clearly linked to overall student performance measures.

Method

In order to protect the overall validity and reliability of the study's findings a mixed-method design was used emphasizing the case study supplemented by survey research and historical, longitudinal data. The case study was selected as the most appropriate method for studying a uniquely complex, social system such as the Central Educational Center. Stakeholder survey research, defined as the solicitation of "self-reported verbal information from people about themselves" (Rea & Parker, 1997, pg. 2), was also used to establish past and current school climate and stakeholder satisfaction that helped inform the overall research foundation used for exploratory and explanatory purposes. Online survey instruments, focus groups, and a review of historical data with a specific emphasis on longitudinal school and student level performance data were also part of the data collection process.

Case and Units of Analysis

To implement a systematic approach in conducting and analyzing the results of a case study of CEC, the school has been examined through the use of multiple embedded units of analysis utilizing two different models: Stufflebeam's (2002) Context, Inputs, Process, and Product (CIPP) evaluation model and Gharajedaghi's system's model of function, structure, and process. The primary case is the Central Educational Center. Within CEC, however, the perspectives of the primary stakeholder groups (students, faculty and staff, administration, businesses, and parents), have been collected and examined. In addition, historical performance data has been gathered and analyzed against the school's stated charter goals and objectives over a five year longitudinal period.

School performance has been assessed using a combination of criterion referenced outcomes identified in its original charter supplemented by stakeholder qualitative comments. Student performance has been examined by a number of methods including the longitudinal value-added impact CEC has had on students compared to their non-CEC peers and the general district level performance measures associated with the school's charter.

Participants and Sampling

Students: Twenty student interviews, two focus groups, and five class room observations were conducted using a combination of purposeful stratified sampling and samples of convenience (representatives selected by the school's guidance counselor). The purposeful sample was one male and one female from each grade level 9-12. In addition five natural observations took place each focusing on a different type of course offered at CEC – An academic course (a math course), a technical high school course (pre-engineering), a technical college course (dental assisting taught by the technical college), one work-based learning course, and the performance learning center which is a virtual high school credit recovery program.

To determine the value-added impact attending CEC has on student performance longitudinally, two groups of students were selected – an intervention and control group. For the intervention group (n=27), students were selected based on the criteria that they had attended CEC for at least two semesters by the end of their sophomore year and were members of one of three pre CEC performance groups based on GPA: High (88%+ or 3.5+ GPA), Medium (70-88% GPA or 2.8 to 3.5 GPA), Low (<70% or <2.8 GPA). The entire population of students fitting the CEC student criteria was 32 10th grade students taken from the 2002-2003 academic year and followed through the 2004-2005 academic year, the year of their expected graduation. This CEC cohort did not distribute equally across the stratified pre CEC performance categories with High (n=10, 31.3%), Medium (n=19, 59.4%), and Low (n=3, 9.4%) and five participants had to be dropped because they did not remain in the school system for the entire three year period. The control group of 27 students represented a stratified sample designed to match the CEC intervention group in terms of performance stratification, gender, and ethnicity. The only variable not matched between the treatment and control groups was base high school.

Data from two 2004 surveys, a satisfaction survey with a sample size of n=490 and a survey conducted by ICLE, International Center for Leadership in Education, with a sample size of n=300 was also used.

Parents: Four parents were also interviewed, three of which were samples of convenience arranged with the school counselor and one selected through purposeful sampling, a parent of one of the students selected through purposeful sampling. Data from a ICLE 2004 survey with a sample size of n=64 was also used.

Faculty and Staff: Five CEC faculty and six CEC staff members were interviewed using a combination of random selection and purposeful sampling from the CEC directory. Four faculty and one staff member was selected randomly from an alphabetical list where their names were selected at random from the list until the desired number of interviewees were identified. The randomly selected staff member was chosen by picking one staff member from the CEC directory.

Two additional surveys were administered to CEC's faculty and staff: the Quality School Assessment Instrument (QSAI) and a faculty and staff satisfaction survey. Overall response rate was 41% (n=27) for the QSAI and 45% (n=30) for the faculty/staff satisfaction survey. Both surveys were sent out via faculty/staff email list serve.

Educational Administrators: The current and past administration for CEC and West Central Technical Center were interviewed – five current and former CEC administrators and two current and former West Central Technical Center administrators. In addition, each of the three principals of the base high schools, which provide CEC with its students, were also interviewed at their respective schools and selected because of their unique perspectives and leadership roles of the schools that partner with CEC on a day-to-day basis. The Superintendent was also interviewed and shared his opinion of how CEC has impacted the school district and his vision for its future.

Business: Four business interviews were also conducted based on a combination of convenience sampling through the assistance of school's CEO and purposeful sampling based on a business's ability to answer specific questions. One business was a work-based learning partner, another business was a temporary employment agency, and the final two were original players with CEC before the school opened.

Community Leaders: Joe Harless was interviewed at length as the originator of the CEC concept. In addition, the original business leader that initially approached the Superintendent about problems with overall student quality was also interviewed at length.

Results

What is the Central Educational Center? A charter school with a twist.

The Central Educational Center first opened its doors in August 2000 and just completed its sixth academic year. It is a non-immersion, charter technical high school that draws students from three base high schools with an average district attendance of 4,746 students per year. Students who attend CEC must work through their school counselors to identify and select courses at CEC that are not offered at their traditional base high schools. Students do not attend CEC on a full-time basis and earn their high school diplomas from their base high school. Another unique facet of CEC is that a Georgia technical college, the West Central Technical College, is also located on their campus so that a select group of qualified high school students are able to take dual-enrolled courses. Two key differences between CEC and most other charter schools are 1) rather than serving as an accountability measure that competes with traditional high schools for students, CEC shares students with their respective base high schools framing the relationship in a collaborative rather than a competitive manner and 2) CEC has partnered with a technical college sharing both facilities and faculty thereby enriching its instructional capabilities above and beyond support provided by the local school district and state department of education.

In terms of general demographics, 615 students attended CEC during its inaugural year (15% of the district's student population) and general student population at the school has increased to an average attendance of 1304 unique students per year or 27% of the district's student population. Ethnically, the CEC student population over the past four academic years on average has been 73% white, 23% black, 2% Hispanic, and 2% Asian/other. In terms of gender, CEC is on average 60% male and 40% female. In terms of grade level, CEC is on average comprised of 6% freshmen (n=67), 28% sophomores (n=320), 39% juniors (n=440), and 27% seniors (n=310).

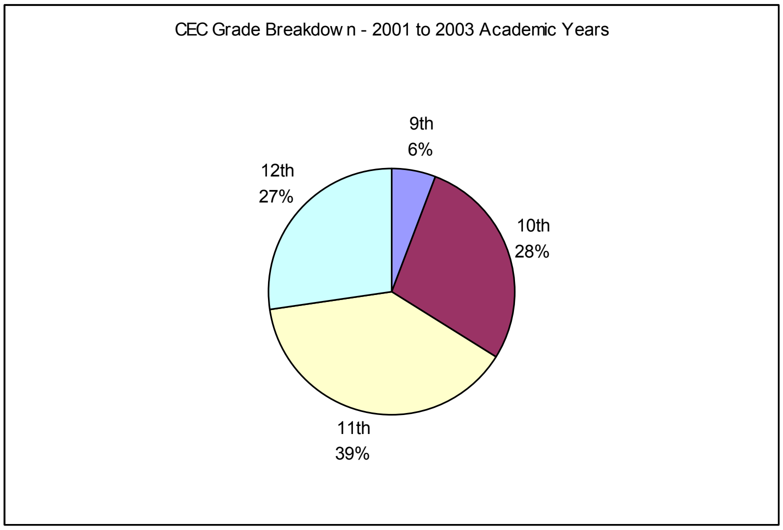

Figure 1 - CEC breakdown by grade

The school district has centralized the majority of technically and career oriented courses at CEC and, although there are a few traditional academic courses offered as well, the majority of students (on average 88% or n=1000) pursue high school technical/career seals of endorsement, which are earned by taking four selected courses in a particular program of study. A small number of students, on average 12% or 138 CEC students per year, take and pass the state's technical college entrance exam as a requirement to getting accepted into the dual enrollment program allowing them the opportunity to take dual-enrolled courses at the technical college. Adult learners, on average 35 per year, also take courses side-by-side with high school students.

Research Questions

Research Question 1: What have been the results of using a system's approach to design, develop, and implement the Central Educational Center?

The proposition that needs to be first addressed in order to answer this research question is to determine the validity of the following statement: *There is a high level of congruence between what is actually in place and Harless's ABCD system model*. The pattern that would be expected if indeed this proposition was true is adherence to ABCD system's process are clear goals that have been identified, resources are identified and allocated accordingly, stakeholder satisfaction levels are high, and frequent evaluation resulting in continuous improvement is occurring. An invalid pattern would be that no clear objectives are identified, poorly aligned resources, low stakeholder satisfaction levels, and either infrequent or no evaluation is taking place.

The results of the study suggest that CEC matches more closely with the valid pattern, which be predicted since Dr. Harless himself led the initial design and planning process. CEC was designed carefully over a four year period from 1997 to 2000. One of the essential elements attributed to the success of CEC is the pervasive commitment begun by the original steering committee of involving all of the major stakeholders in the decision making process from the very beginning. A number of the original steering committee members interviewed remarked how they were skeptical that the steering committee would be productive and successful, especially given so many disparate points of view and potential "turf battles." In a comprehensive interview with Dr. Harless (May 2006), he rated his overall satisfaction level with CEC a 5 out of 10. He was quick to point out, however, that this was a criterion referenced rating based on his high expectations and utmost fidelity to his accomplishment based systems model (the ABCD system). If norm referenced, compared to other schools, the rating would be much higher, especially since CEC has indeed become a state and national model for educational reform. CEC to him is the first pilot test of the vision articulated in the *Eden Conspiracy*.

Dr. Harless noted that in recent years he has added an "A" in front of the traditional ADDIE systems design process. He affectionately calls the new model "Aunt" ADDIE with the new "A" standing for assessment of customer needs prior to an analysis of performance problems. The new model is A-ADDIE. There were a number of goals the he had wanted to see achieved in the implementation of CEC. The first was to demonstrate that a new "A" needed to be added to the ADDIE process. If done successfully, the resulting school would be a first attempt at implementing what he calls needs-based and customer driven education as opposed to the traditional educationally mandated, content based, college focused system we have now. He also saw CEC as a demonstration project of what could happen if content was derived directly from desired ends-based performance or what he calls accomplishments, ends-based quality outcomes. He also wanted CEC to demonstrate the full power and effect of implementing the instructional science called for by instructional systems design principles.

Although, Dr. Harless overall, felt that much of this has indeed been accomplished to some extent, his disappointment rests at a number of key areas along the process. First, the use of the needs assessment, the actual implementation of the results was not done well. He felt that the initial needs assessment represented a macro needs assessment and that what needed to follow was a micro needs assessment to flesh out the specific behaviors and knowledge and skills required by employers in these identified areas. In terms of the use of instructional science, he felt that he was not provided enough time to train CEC's faculty (he was given 35 hours or one work week to provide training) in the complex application of a science he spent over 30 years to perfect. Because of this, he felt that he overwhelmed most of the faculty, and that because of this little or no instructional science is taking place in the classroom at CEC. The third issue rests with a disconnect between true performance-based instruction and content, standards-based instruction. Performance or accomplishment-based instruction works backward to link accomplishment to behaviors that then informs what knowledge and skills need to be taught. Content-based instruction although largely driven by behavioral objectives is missing the direct link to desired accomplishments as defined by the needs of the customers who will be hiring students. One last concern was that although there was considerable evaluation conducted by the author and other research organizations, there had not been any systematic follow-up with graduates or the business stakeholders to determine satisfaction levels and/or needed redesign of the curriculum.

Primary Stakeholders Report High Levels of Satisfaction

CEC students have consistently reported high satisfaction ratings over the past five years. During the data collection that took place May 2006, two student focus groups and over 20 individual interviews of 32 students yielded an average satisfaction rating of 93%. Students like the different classes they can take at CEC that are not offered at their base high schools and also feel like they are treated more like adults in a college campus atmosphere. The strength of the teachers and the preparation for the work force through hands-on activities also were mentioned as tremendous positives. In addition, although usually mentioned as a weakness, the fact that CEC's attendance and tardy policies are so strict helps "make people come to school." The fact that students could earn dual enrolled high school and technical college credit completely for free also was mentioned as a strong aspect of CEC.

Parents also report high levels of satisfaction. An independent survey of CEC parents conducted by the International Center for Leadership in Education in 2004 found parents to be either agree or strongly agree to statements that CEC possesses recognized criteria for effective schools such as safety (95%), my child knows what is expected of him/her (97%), and the school is helping develop my child (94%). All four of the parents interviewed during the most recent data collection reported general satisfaction of 9.5 out of 10. The only rating not a 10 was an 8 due to some large class sizes in some of the academic courses (i.e. economics) and also because CEC is bit sparse in its technology curriculum. Other factors behind the ratings include "CEC has all of the advantages" and that their children really like CEC. Per one parent, "Experience is usually the best teacher; (CEC helps) channel their energy to help themselves."

Faculty, staff, and administration also report high levels of satisfaction. A faculty and staff satisfaction survey has been conducted at CEC every other year, a total of three times over the past six years. The satisfaction ratings have been consistently high with a 9.3 out of 10 rating (n=25) in 2002, 9.3 out of 10 in 2004 (n=37), but fell to an 8.0 in 2006 (n=30). Another faculty survey conducted by the International Center for Leadership in Education (ICLE) in the spring of 2004 as part of the Bill and Melinda Gates' National Model High School Award. 33 faculty and staff responded to the survey. The faculty overwhelming agreed that the school had high academic standards

(97% agreed, n=10, or strongly agreed, n=22), had a clear mission (100% agreed, n=6, or strongly agreed, n=27), and set high expectations for quality teaching (97% agreed, n=6, or strongly agreed, n=26).

In terms of general satisfaction level, four directors were interviewed in May 2006. One director called his job at CEC a "teacher's dream" with students who want to be there, small classes, long lunch breaks, and plenty of planning time along with no unnecessary meetings or activities and plenty of opportunity to experiment. Another director noted that she had taught at different high schools and they were much more "massive." At CEC there is more of an adult atmosphere and students rise to the occasion and behave accordingly. In addition the administrative support is outstanding. One director noted that he was happy with CEC but felt frustration over not growing fast enough as there is so much he wants to do personally and professionally. Another director noted there "is always room for improvement" and that in many ways it was the negative attitudes of the base high schools that were a product of growing pains that caused a certain degree of dissatisfaction. In terms of their colleagues, however, they felt that the satisfaction was a lot lower at 63%. There was frequent mention of educational bureaucracy and the high level of turnover of CEC administration (all three CEC administrators left at the end of the 3rd year). One director felt that there was a high level of satisfaction but that some bad habits had formed during the time that all three of the founding administrators left after year three. Another prominent source of dissatisfaction is with general communication with existing administration and a feeling that they are simply "treading water" and "missing direction" but they cannot quite put their finger on what the problems are as a faculty.

The faculty also recently completed a school climate survey called the Quality School Assessment Instrument (QSAI) which seeks to measure how a school compares to factors identified in the school effectiveness literature. 27 faculty, staff, and administrators completed this instrument online. Some results of interest include the fact that the top rated item Question 11, "Attractive, safe facilities with adequate physical resources" was the only item that had an average rating above a 4.0, which is slightly above "at expectation". The second highest rated item was Question 42, a report card item, which asked "how safe is your school?" A 3.45 rating suggests that CEC faculty and staff feel safe in their school environment. The QSAI report card, the final 9 questions, "grades" a school on nine essential factors of effective schools. On these nine items the grand mean was a 3.2 out of 5, which translates to a slightly above average rating. Items of interest include responses to Question 50, "How do you grade your school overall?" (3.1 rating), Question 45, "What is the quality of teaching at your school?" (3.3 rating), and Question 48, "Does your school provide a quality experience for students?" (3.4 rating).

The Superintendent of the Coweta County School District and the principals of the three base high schools also expressed high levels of satisfaction with CEC. Each of them felt that CEC was good for Coweta County and did indeed do good things for their students that attended. Positives noted include strong programs and technology, teaches students responsibility, and allows students to see a broader spectrum of the work world. The Superintendent also sees CEC and charter schools as representing the flexibility to "think out-of-the box" and try new things without being penalized. The shared concerns of the principals can be categorized into two primary problem areas: 1) Serving the largest number of students who most benefited from vocational education and 2) Administrative and operational problems caused by their students attending CEC at various hours of the day. The first issue has to deal with total numbers of students served through technically oriented courses. Two of the three principals explicitly noted that CEC was not serving enough students.

CEC School Performance

An analysis of the school's performance across its charter objectives indicates that the school has had success achieving these stated objectives. Of three measurable charter objectives, CEC achieved its county drop out rate target of less than 8% each year (3.10%, 5%, 5.12%, and 4.93%, respectively). In addition, in terms of first time pass rates on the Georgia High School Graduation Test, of the four subject areas CEC directly impacts (writing, English/Language arts, Mathematics, and Social Studies), CEC achieved its county wide target 100% of the time in Science (4 of 4 times), 75% of the time (3 of 4 years) in English/Language Arts, 50% in Mathematics (2 of 4 times), and 0% in Writing (0 of 4 times).

One of the primary problems, however, of trying to use county wide aggregate data is that attempting to establish any kind of causality to CEC is speculative at best. During each of its first six years, on average 25% of all Coweta County high school students have taken at least one course from CEC each academic year. In order to more clearly determine the impact of CEC on student performance two groups of students were tracked over a three year

period – a treatment group of CEC students (attended at least two semesters by the end of the 10th grade year) with a sample size of n=32 and an identical control group of students who did not attend CEC at all also with a sample size of n=32 – stratified across three performance groups (high, medium, and low) based on GPA prior to their 10th grade years.

Comparing the two groups across repeated measures over a three year period on three variables, GPA and unexcused absences and instances of tardiness yielded interesting results. Overall average GPA over a four year period from 9th grade to 12th grade little overall change with either the CEC Treatment group (increased 0.83 points from 83.13 GPA in 9th grade to 83.96 average GPA in 12th grade) or the Control group (increased 0.03 points from 82.67 GPA in 9th grade to 82.19 average GPA in 12th grade). Trends in unexcused absences and instances of tardiness, however, indicate clear differences between the two groups. For unexcused absences the CEC treatment group dropped an average of 25% from 10th to 12th grade compared to only 6% for the non-CEC control group. See Figure 2 below.

For unexcused instances of tardiness the difference was even more dramatic with the CEC treatment group reducing instances of tardiness by a statistically significant 56% from 10th to 12th grade while the non-CEC group actually had an overall average increase of 51%. See Figure 3 below. An independent samples t-test showed a statistically significant effect for instances of tardiness, $t(52) = -2.71$, $p < .001$, with the CEC group having a substantially lower number of instances of tardiness than the control group at the 12th grade level. In addition there was a moderately negative relationship between performance level and instances of unexcused tardiness at the 12th grade level, $r(25) = -.44$, $p < .01$, suggesting that low and medium performing students decreased instances of unexcused tardiness from 10th to 12th grade while their counterparts in the control did not.

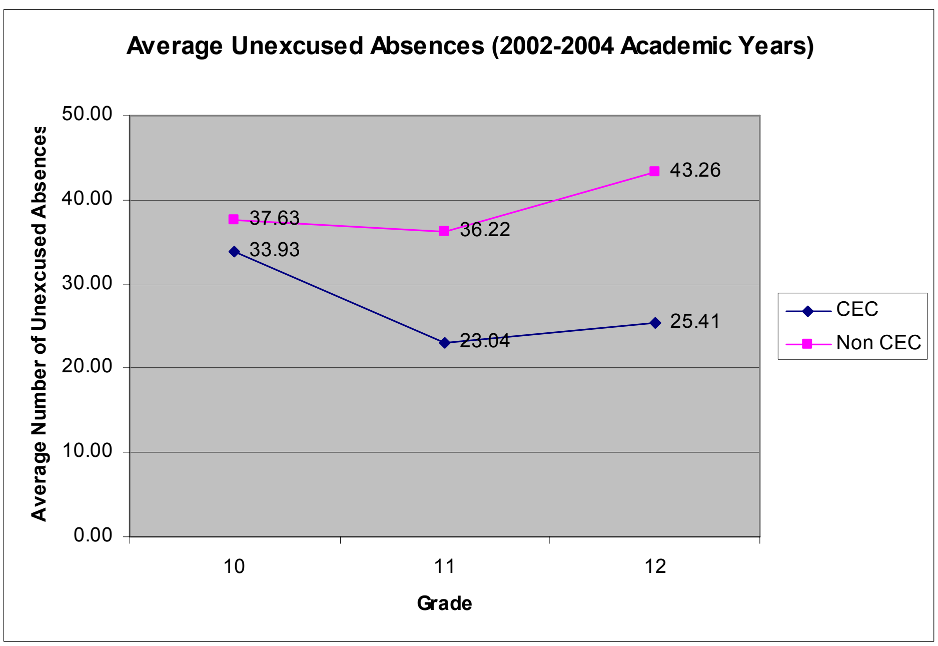

Figure 2 - Unexcused Absences (2002-2004)

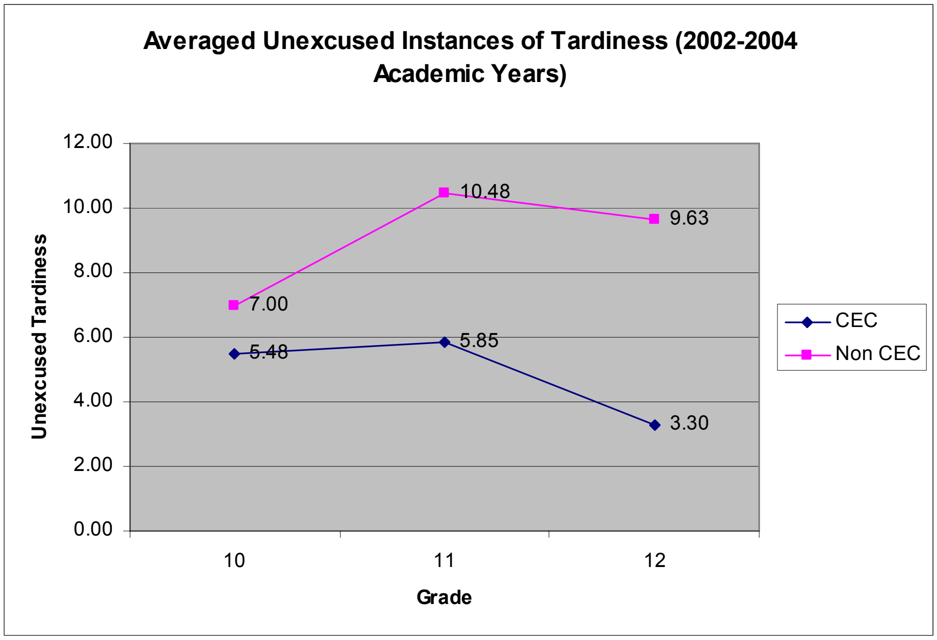

Figure 2 - Unexcused Instances of Tardiness (2002-2004)

Statistically significant correlations of note for the CEC Intervention group included a moderately strong relationship between gender and 12th grade GPA with $r(25) = .53$, $p < .01$ that indicated girls performed consistently higher in terms of GPA than boys from 9th to 12th grade. Also a strong relationship was found between pre-CEC and 12th grade GPA with $r(25)=.847$, $p<.001$, which indicates that there was little improvement in GPA for students prior to and after attending CEC. Another pair of interesting relationships were, ironically, a moderately strong positive relationships between pre-CEC GPA and an increase in unexcused 12th grade absences, $r(25)= .52$, $p<.01$, and also unexcused instances of tardiness, $r(25)=.41$, $p<.05$), which suggest an increase in both for higher performing students. Another correlation which presents a different way of looking at this same relationship is that there was a moderately negative relationship between performance level and instances of unexcused tardiness at the 12th grade level, $r(25)= -.44$, $p<.01$ which suggests that low and medium performing students decreased instances of unexcused tardiness from 10th to 12th grade. A set of relationships where it is good to not have a strong relationship was between instances of unexcused absences and tardiness from the 10th to 12th grade level; in other words there was a general reduction of both across students with no significant relationship trends between those who had high instances of both at the 10th grade level as compared to the 12th grade.

For the Non-CEC control group there were some similarities and also differences with the CEC intervention group in terms of statistically significant relationships amongst variables. Similarities included a moderately strong positive relationship between gender and 12th grade GPA, $r(25)=.386$, $p<.05$ where girls started with higher GPAs in 9th grade and ended with higher GPAs overall in 12th grade. Another similar relationship were the strong relationships between 9th grade GPA and 12th grade GPA, $r(25)=.821$, $p<.01$again suggesting that student GPAs remained relatively static during this time. An interesting difference in the control group data, however, were that strong positive relationships were found between 10th grade and instances of unexcused absences and tardiness with 11th grade and 12th grade levels – for unexcused absences the correlation between 10th and 11th grade was $r(25)=.741$ and for 10th and 12th $r(25)=.691$ both at the $p<.01$. The pattern was similarly strong for unexcused instances of tardiness where the correlations between 10th and 11th was $r(25)=.596$, $p<.01$ and 10th and 12th grades was $r(25)=.653$, $p<.01$.

Discussion

CEC represents an interesting opportunity to see what impact using system's principles would have on a public school. In particular, this school represents a pilot test for the use of Harless's ABCD system and the unveiling of his recent addition of a new "A", assessment, to the traditional ADDIE model making it now A-ADDIE. Harless also wanted the CEC implementation to represent an example of needs-based as opposed to content based education. The results of this study suggests that CEC has used many aspects of system's principles and had a positive impact on many fronts while at the same time being faced with a number of opportunities for improvement.

Harless from a criterion referenced standpoint rated his overall satisfaction level with CEC a five out of 10 or 50% level of satisfaction. He was also quick to point out that from a norm-referenced standpoint, in comparison to how other schools were doing, he would rate CEC much higher. Compared to his expectations, however, CEC is only half way there to adhering to the overall fidelity of his ABCD model and vision for what he wants it to become. His rationale included the fact that necessary comprises had to occur along the way that diluted the overall application of the ABCD system. During the Assessment phase (the first "A" in A-ADDIE) for example a misalignment occurred between the findings of the needs assessment, identification of specific skills associated with the jobs identified, and selection of the curriculum that was offered by CEC. Two primary reasons for this were that 1) both high school and technical college courses already existed and existing curriculum is always easier to use and 2) selection of curriculum occurred primarily using content and subject-based standards rather than behavior oriented, performance based skills. Three other major disappointments Harless had were the overall lack of training and preparation of the teachers with his instructional science principles (he received only 30 of the 80 hours of training needed), the lack of systematic follow up with graduates of CEC, and the minimal impact CEC has had on the local educational community in terms of educational reform.

In many ways, however, it appears that system's principles are working, especially in the front Assessment and Analysis phases and the back end Evaluation phase. By conducting a comprehensive needs assessment over a two year period not only were the specific job needs of employers identified, which surprisingly emphasized the need for soft skills (i.e. work ethic) over hard skills, most importantly a level of buy-in and cooperation amongst major stakeholders took place to collectively address the problem of education. As a result of this collaboration, the decision to use charter school status was made that not only gave CEC the freedom to innovate but also served to create the economic conditions that made the school a true joint-venture between major partners, all of whom share the financial benefit of a CEC student. This is a major difference between CEC and most other charter schools - it is a non-immersion school whose students belong to one of three base high schools and at times also are shared by a technical college as well. This appears to have created a positive environment of collaboration as opposed to the traditional competitive conditions focused on district wide accountability charter schools are typically associated with and general stigma going exclusively to a technical school traditionally has. Given the desired outcomes of employers and an infrastructure built around consensus and collaboration, CEC then garnered legislative and financial support from the highest echelons of Georgia state government – direct support from the Governor himself – and was provided over $14 million in initial funding and capital support (including the building and land CEC was built upon). Prior to opening its doors CEC appeared to be built on a solid foundation for success.

The mission of CEC became "To create a viable 21st Century workforce" and it generated tremendous amount of local and statewide support and recognition anointed by the Governor as the model for technical educational reform for the state. Momentum was strong. Yamaha even decided to remain and expand its golf-cart manufacturing plan, at an estimated initial economic impact of $75 million to the local economy, because it felt that the presence of CEC would provide the kind of local skilled labor it needed to be successful. Six years later, what can be said about what we have learned from CEC about the use of system's principles in public education and what impact has it had on students?

The apparent success of CEC suggests that the use of system's principles, especially given the rise of charter schools, provides an opportunity to take major tenets of performance technology - such as being customer and needs-based focused – and apply it successfully to public education. CEC represents the application of system's thinking more from a macro rather than micro perspective with greater fidelity to the A-ADDIE process in the front and back end stages wrapped around the curriculum of mostly existing technical education and the traditional talent and experience of professional career educators, the majority of whom have little or no training with Harless's ABCD system or formal instructional design methodology. With this reality, however, is the recognition that both

the technical curriculum and the teaching methodology centered on teaching mainly courses focused on technical skills, appear to inherently adhere to major system's principle tenets including clearly identified and articulated ends-based performance outcomes, hands-on practice, and a broad range of mixed methods of instruction.

On the evaluation side of the A-ADDIE process, CEC through Dr. Harless approached FSU's Instructional System's program to help with evaluation during their first year of operation. Evaluation has been consistent and focused on both formative and summative areas ever since. Ultimately, using a system's framework to guide the evaluation process, the decision was made to focus resources primarily towards the inner working of CEC as a living, breathing system. In other words, attempting to understand what CEC was and to what degree stakeholders were satisfied became the primary focus emphasizing Ghiradeghi's (1999) system's definition of function, structure, and process. In the past two years, however, the evaluation efforts have shifted steadily towards summative evaluation of end-results leading up to the creation of a viable, sustainable process for following graduates into their post-secondary lives. The scarcity of consistent feedback from graduates and businesses represent two major limitations to the current study due to significant constraints in time and resources in which to do so.

In terms of empirical results, the charter objectives of CEC, all of which initially were district level measures, have been favorable. Drop out rates were reduced by over 60% district-wide in the first year CEC was opened and have remained low. Ironically, there has been also a spike in district-wide SAT scores close to a 100 point increase also since CEC has opened its doors. With on average only 25% of the county high school students attending CEC each year, however, it is not possible to link either district-wide measure to CEC outcomes. But, as charter objectives nonetheless, CEC has consistently met them (CEC has since changed its charter objectives at the end of its fifth year to more measurable objectives). Stakeholder satisfaction has been consistently high on a longitudinal basis across students, administrators, and parents. The common theme being the hands-on approach emphasizing preparation of students towards a life beyond high school, which appear to be at odds with "traditional" high school academics that appear to more focused on preparing for college. The one negative consistently mentioned is the strict tardiness and attendance policy administered by CEC. In addition, CEC faculty have reported their lowest satisfaction ratings in its six year history (80% satisfied) and appear to be struggling with the high turnover rate of general administration and the role they play in helping establish and implement CEC's mission and vision. The two primary areas of dissatisfaction appear to be with the dissonance occurring between specific educational administrators and a subset of faculty and a changing curriculum driven by student enrollment that is redefining the course offerings and has led to reevaluation of positions and, in some cases, even an apparent loss of jobs.

Comparing intervention and control groups across a three year period suggests several trends. First, both groups in terms of GPA, remained consistent over time and improved little from 9^{th} to 12^{th} grade. This suggests that CEC as well as the three base high schools do not appear to improve academic performance in terms of grades beginning at 9^{th} grade – student performance remains relatively static throughout their high school careers. Another interesting finding is the differences in performance between boys and girls both which were similar across groups with girls having a higher mean GPA than boys at the 9^{th} grade level and maintaining this difference throughout high school. This could be caused by the fact that there were more boys than girls in each group or suggest a meaningful difference that needs more in depth research. The major impact CEC appears to be having on students that differentiates itself from the control group is the impact on the soft skills as measured by unexcused absences and instances of tardiness – CEC students showed a statistically significant drop in unexcused instances of tardiness from 10^{th} to 12^{th} grade and, most importantly, showed no significant correlations between overall absences or tardiness from 10^{th}, 11^{th}, and 12^{th} grade meaning the major offenders at the 10^{th} grade level improved over time in both areas. For the control group, however, overall absences and tardiness increased over time and there were strong correlations between major offenders in the 10^{th}, 11^{th}, and 12^{th} grades suggesting their relative behavior experienced little to no change over time.

There are three major limitations to this study. First, GPA by itself is not a strong measure of academic performance and thus, any conclusions must be tempered by the lack of a robust indicator of academic performance. The author is working with the school district to collect additional measures of academic performance, including graduation rate and standardized test scores, for all students in both groups. Second, the lack of data from both graduates and business stakeholders – not having this data minimizes the overall impact of this study's results as both represent major stakeholders for CEC. At this time, only anecdotal data has been collected that does suggest general satisfaction for both groups. And, Third, small sample sizes in terms of both qualitative and quantitative data

collection. At this juncture, as Dr. Harless has pointed out, there has not been a consistent, established system for data collection across time that would generate the necessary results needed to ensure proper input from major stakeholders. Although consistent evaluation has occurred the overall evaluation design has not been well integrated into the day-to-day operations of the school.

CEC has begun its seventh year as a 2004 model high school award winner and recognized model for educational reform for the state of Georgia. Three separate dissemination efforts are underway currently in Georgia and the model is receiving national attention as well. The results of the study suggest that system's principles have indeed been used effectively in the design, implementation, and evaluation of the school to some level of success – major stakeholders appear satisfied, what appears to be a significant impact on soft skills across time, and continuous emphasis on improvement and evaluation. This success suggests that indeed, given the right circumstances and support, that system's principles can be used effectively, especially given the rapid growth of charter schools nationwide. Despite CEC's current success, opportunities for improvement abound including the need to address gaps in its research and evaluation system that follow graduates into the post-secondary world, working with faculty to help reconnect them to the mission and goals of CEC given a changing curriculum defined by student enrollment and an administration characterized by high turn over, and the need to continuously improve its operations especially so that it continues to be deserving of its model school status and can support efforts by others to replicate this model.

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Tool Use in Open Learning Environments: In Search of Learner-related Determinants

Geraldine Clarebout & Jan Elen
Center for Instructional Psychology and Technology
Katholieke Universiteit Leuven

Introduction

Various established researchers make the claim that open learning environments (OLEs) may foster the acquisition of complex problem solving or higher order reasoning skills (Jacobson & Spiro, 1995; Jonassen, 1997). OLEs typically confront learners with problems that they have to investigate from different perspectives in order to propose an adequate solution. Considering multiple perspectives is argued to stimulate students' cognitive flexibility which in turn enables students to deal more easily with new complex problems (Krems, 1995; Spiro, Feltovich, Jacobson, & Coulson, 1991; Jonassen, 1999). Jacobson and Spiro (1995) report a study in which students confronted with a complex problem in an OLE (hypertext environment) perform better on a transfer task than students who were confronted with the same problem in a computer-based drill and practice format. These findings are explained by referring to inert knowledge acquired by learners in the 'closed' learning environment condition. To avoid such 'functional fixedness', Anderson (1990) proposes to introduce in OLEs problems in all their complexity. Several other researchers (Barab & Duffy, 2000; Honebein, Duffy, & Fishman, 1993; Spiro et al., 1991) have also suggested that problems in OLEs should be as cognitively demanding as problems in the 'real world'.

Apart from a complex authentic problem, these OLEs are typically characterized by a large amount of learner control. The environment encourages learner-initiated enquiry and manipulation of the learning environment (Hannafin, Hall, Land, & Hill, 1994). The exploration and manipulation of the different components of the learning environment also entails deciding on the use of different support tools. More specifically, in order to receive support in OLEs students have to decide themselves when the use of a specific tool could be beneficial to their learning. In other words, the provision of OLEs rests on the assumption that learners are high self-regulators. While this might be the case for specific groups of learners, research on learner control (Friend & Cole, 1990; Goforth, 1994; Large, 1996; Williams, 1996) reveals no clear benefit of learner control on learning. The main reason exactly is that students are not always capable of making adequate decisions with respect to their learning process.

Research on tool use corroborates this finding. Students indeed tend to disregard or inadequately use support devices that are put to their disposal (Aleven, Stahl, Schworm, Fischer & Wallace, 2003; Clarebout & Elen; in press). If students do not or inadequately use tools and are not capable of making adequate decisions, doubts raise about the effectiveness of OLEs.

In view of the design of effective OLEs it is important to gain more insight in the variables that influence tool use, more precisely learner-related and environmental factors. With respect to the environmental factors some studies have already been done. For instance, the influence of advice on tool use has been addressed by Lee & Lehman (1993) and by Gräsel, Fischer, and Mandl (2001). Both studies reveal a beneficial effect of advice on tool use, i.e. the frequency of tool use increased for those students receiving advice versus those students who did not receive advice. Another environmental factor studied was instructional method. Crooks, Klein, Jones, and Dwyer (1996) compared a group of students working individually on a task and a group of students working co-operatively. They found that students working individually more frequently used tools than the co-operative groups. Unfortunately, Crooks, Klein, and Savenye (1998), could not replicate their findings.

This contribution focuses on learner-related variables, more specifically metacognitive variables. The impact of metacognitive skills, such as monitoring and regulation, on tool use has not yet been explored, despite the theoretical relevance of these variables (Clarebout & Elen, in press). Other student-related variables were already studied, but overall no clear effects were found (for reviews see: Aleven et al., 2003; Clarebout & Elen, in press). Some studies for instance, report an effect of prior knowledge and ability (e.g., Viau & Larivée, 1993), while others do not find such effect (e.g., Schnackenberg & Sullivan, 2000). The same is true for learning style, where some do (e.g., Carrier, Davidson, Higson, & Williams, 1984) others (e.g., Lee & Lehman, 1993) do not find an effect.

This contribution investigates the impact on tool use of three metacognitive variables: students' regulation activities, help-seeking behavior, and instructional conceptions. In line with Flavell (1979) and Vermunt (1992), regulation activities are activities students undertake to regulate, monitor and control their own cognitive processes. Regulation activities comprise the application of cognitive and environmental resources as

demanded by the task (Newman, 1998). It is hypothesized that students' regulation skills will have a positive influence, resulting in increased tool use in OLEs.

Newman (1991, 1994) defines help seeking behavior as efficiently seeking for assistance when a lack of comprehension is perceived. Help seeking also includes the ability to identify one's own problem, i.e. of monitoring one's own knowledge (Schunk & Zimmerman, 1994). Aleven et al. (2003) suggest that help seeking behavior is related to tool use. The more students show help seeking behavior, the more they will be inclined to use tools. Or, the more students tend to avoid help, the less inclined they will be to use tools. The literature on help seeking (Newman, 1991; Pajares, Cheong & Oberman, 2004) also considered the perceived benefits of help seeking as an aspect of, or as being related to, help seeking behavior. In his study, both help avoidance behavior and perceived benefits of help seeking are studied in relation to tool use.

Students' instructional conceptions have been described as a particular kind of metacogntive knowledge (Elen & Lowyck, 1999). They are defined as 'all ideas, concepts, and theories that an individual learner holds about (components of) a learning environment.' (Lowyck, Elen & Clarebout, in press). Winne (1985, in press) states that the functionality students ascribe to a tool, will determine whether, and how they use this tools. Hence, it can be assumed that instructional conceptions influence tool use. A typical example of the impact of instructional conceptions is provided by André (1979). In this study, pre-questions were provided to students to give examples of test items. But rather than using these items as examples of test, students used them to determine what was important in the course book. As such, it is hypothesized that the more students conceive the tools as functional to problem solving, the more they will be inclined to use them.

Figure 1 provides the model that will be tested in this contribution. Since all independent variables relate to a specific part of metacognition, they might be correlated. The lines between the independent variables illustrate these possible correlations.

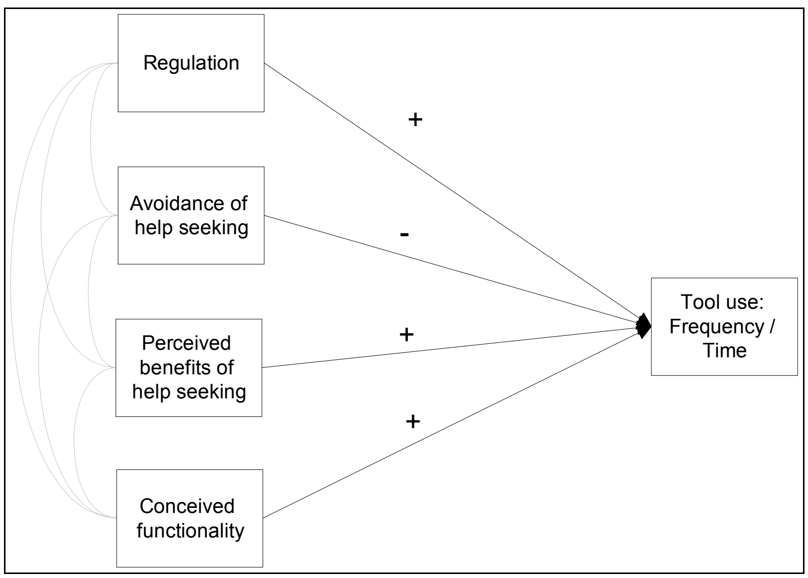

Figure 1: Schematical model

Methodology

This study was part of a broader research project in which the effect of advice on tool use was studied. Students in the study were randomly assigned to one of three groups: a control group without advice (C-group), an experimental group with adapted advice (AA-group) and an experimental group with fixed advice (FA-group) (Clarebout & Elen, 2005). Since these groups differ with respect to this instructional intervention (kind of advice), the influence of learner characteristics will be studied in each of these groups separately and compared to one another.

Participants

Participants were 185 first year educational sciences students. Participation was voluntary, but participants could earn 10% of their grades for an introductory course on 'Learning and Instruction' when they participated.

Materials

Study materials. A computer-based learning program, called STUWAWA, was developed using Macromedia Director. STUWAWA confronts student with an ill-structured problem: the selection of the most environmental-friendly drinking cup for a music festival, by considering ecological, financial and safety aspects. In view of increasing authenticity, this complex problem was introduced on video by a member of a neighborhood committee requesting the students for help to deal with the problem. STUWAWA contains different types of tools, namely information resources (e.g., information list; videos), performance support tools (e.g., calculator), and knowledge monitoring tools (e.g., problem solving script). The different tools provide access to information and support students' cognitive processes. Students decided themselves whether or not to use the tools. Figure 2 provides a screenshot of the learning environment (see Clarebout & Elen, 2004 for a detailed description).

Figure 2: Screen dump of STUWAWA

Regulation activities. Students' regulation activities were assessed with the metacognition items of the Learning Style Inventory (LSI) of Vermunt (1992). The LSI is a widely used instrument to measure students learning styles (e.g., Boyle, Duffy, & Duleavy, 2003; Schouwenburg, 1996; Veenman, Prins, & Verheij, 2003). Students were asked to indicate on a six-point Likert type scale their level of agreement (1 = totally disagree; 6 = totally agree) with 28 statements of the LSI relating, to students' regulation activities. These 28 items measure three types of regulation (Vermunt, 1992): self-regulation (e.g., After each paragraph I try to formulate the learning content in my own words to test my learning progress.), external regulation (e.g., I study according to the instructions given in the study materials or provided by the teacher.), and lack of regulation (e.g., I notice that it is difficult for me to determine whether I master the subject matter sufficiently.).
Help seeking behavior. For help seeking behavior the instrument of Pajares et al. (2004) was translated in Dutch and adapted to the context. This adaptation involved replacing 'computer science problems' by 'solving problems'. Students reported the extent they agreed with the different statements on a six-point Likert type scale. The instrument consists of 9 items measuring students' help avoidance behavior (e.g., I would write down any answer rather than ask for help in class.) and 6 items measuring students perceived benefits of help seeking (e.g., I think asking questions in this class helps me learn.).
Instructional conceptions. The ICON-questionnaire was used to determine students' instructional conceptions (Clarebout, Sarfo, & Elen, 2004). Students were asked to indicate on a Likert-type scale to what extent they agreed that certain tools were functional to solving complex problems (e.g., According to me, a problem solving script helps students to better understand the content.). For each tool, a short explanation was given of the tool's functionalities.
Log files. To register students' tool use log files were kept in an Access database. This allowed to register students' actions in an unobtrusive way (Jackson, 1990; Young & McNeese, 1995). The database contains students' identity, all clicks they made in the program, the time when they clicked on a tool, the starting time and the ending time.

Procedure and Design

During the first class of the course on Learning and Instruction, the different instruments measuring learner characteristics were administered. Students were asked to put their name on the questionnaire in view of linking the questionnaire to the log file data. In a second session, students worked individually with

STUWAWA. The introduction for this second session was identical for all participants. The researcher explained that participants would have to solve a problem on the computer, that they had maximum one hour to solve the problem and that after that hour they had to deliver their solution. Students could work at their own pace for a maximum of 1 hour. When students finished they were kindly thanked for their participation and asked to not inform the others about the content of the problem.

Data analyses

To ascertain the influence on tool use, two dependent variables were considered, namely frequency of tool use, and the proportion of the total time spent on tools. The frequency of tool use is the sum of all clicks students make to access a specific tool. The total time proportionally spent on tools is the sum of the time spent on all tools divided by the total time spent on the problem.

For the different instruments, first reliability analyses were performed using the internal consistency measure Cronbach Alpha. In line with Fraenkel and Wallen (2003), an alpha-value of .70 will be considered as representing a good internal consistency. Scales were constructed by summing up the scores on the different items and dividing the sum by the number of items. These scales were used in further analyses. First, correlations between the independent variables were calculated to check whether there was a problem of multicollinearity between the independent variables (Tacq, 1997). Since the four independent variables are all assumed to measure an aspect of self-regulation, multicollinearity might indeed constitute a problem, and should be controlled for (Cohen, Cohen, West & Aiken, 2003; Tacq, 1997). Second, it was checked through a MANOVA whether the three groups, the AA-, FA- and control-group, differed with respect to the independent variables. Next, regression analyses were done separately for each group and for each dependent variable. For these regression analyses, all different models were explored for all three groups: first models with the four independent variables were entered, next models with combinations of three independent variables, then models with combination of two independent variables and finally for each independent variable separately. This allowed to identify for each group the best model, looking at the R^2, and to gain more insight in the role these independent variables play in the model. The t-values for the different variables provide information on the contribution of each independent variable to the model. This method was opted for rather than a 'stepwise regression analysis', since problems have been reported (such as increased Type-I errors) when using stepwise regression for theory testing (Menard, 1995; Cohen et al. 2003). Additionally, the VIF-index was looked at as a double check for multicollinearity (Cohen et al., 2003).

Results

Overall, the internal consistency analyses (see Table 1) show good reliabilities for the self-regulation-, the help avoidance-, the perceived benefits of help seeking-, and the instructional conceptions-scale. Hence, these scales will be used in further analyses. Two LSI-scales, namely the external regulation and the lack of regulation scale, show weaker reliabilities, and are not used in further analyses.

Table 1: Cronbach Alpha for LSI-scales, Help Seeking Behavior Scales, and the ICON-scale

Scale	Cronbach Alpha
Learning Style Inventory	
Self-regulation	.80
External regulation	.62
Lack of regulation	.68
Help seeking behavior	
Help avoidance behavior	.90
Perceived benefits of help seeking	.86
ICON-questionnaire	
Conceived functionality	.91

The correlation matrix for the independent variables is presented in Table 2. Some correlations are significant. A negative correlation is found between avoidance of help seeking behavior and the perceived benefits of help seeking behavior in the AA and FA-group. In the FA-group, an additional positive correlation is found between the conceived functionality of tools and self-regulation. In the control-group no significant correlations were found.

Since, these correlations are rather low, no problem with multicollinearity of the independent variables is expected, unless the tolerance values or the VIF index indicated otherwise.

Table 2: Correlation Matrix for the Independent Variables for the Three Groups

	HA	BH	CF	SR
AA-group				
HA	1.00			
BH	-.329*	1.00		
CF	-.024	-.002	1.00	
SR	-.175	.101	.162	1.00
FA-group				
HA	1.00			
BH	-.285*	1.00		
CF	-.196	.015	1.00	
SR	-.238	.158	.428**	1.00
C-group				
HA	1.00			
BH	-.027	1.00		
CF	-.203	-.141	1.00	
SR	-.261	.121	.214	1.00

HA = help avoidance; BH = perceived benefit of help seeking behavior,
CF = conceived functionality; SR = self-regulation

The MANOVA with the different groups (AA, FA, and control) as independent variables and the four learner characteristics as dependent variables did not show any significant effect ($\lambda = .957$; $F(8,332)=.923$; $p > .05$; $eta^2 = .02$). This means that on average the groups do not differ with respect to these learner characteristics. While based on the correlations between the variables one could argue that the groups do differ, none of these correlations differ significantly between the groups.

In a first step of the regression analyses, for all three groups a full model was tested, i.e. it was studied how much of the variance in the dependent variable could be explained by the four independent variables in each group. The results of the regression analyses for the three groups are presented in Table 3.

In a first section, the results are discussed with respect to frequency of tool use, in the second section, those with respect to the proportion of time spent on tool use.

Table 3: Regression Outcomes for the Three Groups with Four Independent Variables (IV)

Group	R^2	IV	Beta	t-values
		DV= frequency of tool use		
AA-group	.019	SR	.023	.164
		HA	-.009	-.060
		BH	.074	.521
		CF	.106	.776
FA-group	.14*	SR	.170	1.232
		HA	.058	.436
		BH	-.113	-.869
		CF	-.384	-2.773*
C-group	.045	SR	-.007	-.049
		HA	.147	.957
		BH	.115	.792
		CF	-.075	-.504
		DV= proportion of time spent on tool use		
AA-group	.10	SR	-.016	-.117
		HA	-.080	-.576
		BH	-.258	-1.886
		CF	-.204	-1.560
FA-group	.12	SR	-.203	-1.448
		HA	.275	2.042*
		BH	.050	.375
		CF	.029	.204
C-group	.053	SR	-.168	-1.100
		HA	-.090	-.591
		BH	.164	1.131
		CF	.087	.585

* significant on .05-level

Frequency of Tool Use

The analysis reveals a significant model for frequency of tool use for the FA-group. This model explains 14% of the variance in frequency of tool use. The model shows that in the case of fixed advice self-regulation and help avoidance contribute positively to frequency of tool use, while the perceived benefits of help seeking and the conceived functionality contribute negatively. The t-values of the independent variables reveal that mainly the conceived functionality predicts frequency of tool use. The more students conceive tools as being functional, the less frequent they use them in the group with fixed advice (FA-group). For the other two groups no significant model, nor a significant predictor for frequency of tool use was retrieved.

In the consequent regression analyses, models with three, two and one independent variable were tested to gain more insight in the effects of the different independent variables. For the control group and the adapted advice group no better models could be found for frequency of tool use.

For the fixed advice group, it was found that when leaving out the help avoidance variable, the model still explains 14% of the variance in the dependent variable. Self-regulation activities (beta = .166, t = 1.209) and the perceived benefit of help seeking behavior (beta =-.130; t = -1.053) are not significant, but removing them from the model, reduced the R^2 to .09. The conceived functionality variable in the SR-BH-IC model had a beta-value of -.394 and a t-value of -2.898. The F-test to check for significant differences between the R^2 values of the different models (Cohen et al., 2003), did not receive any significant difference between the 4, 3 or 1-variable model ($F = 1.071$; $p > .05$). From these results it can be concluded that especially students' conceived functionality predicts the frequency of tool use. However, removing self-regulation and perceived benefits of help seeking behavior reduced significantly the predictive value for the conceived functionality. As such, a model for the fixed advice group, including these variables leads to a better prediction of frequency of tool use than one without these 'non-significant' variables.

Proportional time spent on tools

For the proportional time spent on tools, no model reached significance, but for the fixed advice-group a significant effect was found of help avoidance behavior. This variable contributed positively to the

proportional time spent on tools. Meaning that the more students indicate to avoid help seeking behavior, the more time they spent on tools.

With respect to the time spent on tools, no significant model could be found for the AA and C-group by leaving out certain variables. However, an almost significant ($p = .06$) effect is found of perceived benefits of help seeking when leaving out the self-regulation variable for the adaptive advice-group. This result suggests that the more students perceive help seeking as beneficial the less time they spent on tools. For the fixed advice-group a significant model was found with three independent variables ($R^2 = .13$), when removing the conceived functionality variable (see Table 4). Deleting the perceived benefits of help seeking variable in this model gives the same R^2-value (Table 4). The regression coefficient for self-regulation activities and help avoidance did not change significant when removing the other variables from these models. The model indicates that the less students are inclined to engage in self-regulation activities and the more they indicate to avoid help seeking behavior, the more time they spent on tools.

For none of the models, the tolerance value and the VIF-index revealed problems with collinearity; and no problems could be found with nonlinearity of the data.

Table 4: Two Models of the FA-group for Time Spent on Tools

Group	R^2	IV	Beta	t-values
FA-group	.13	SR	-.201	-1.606
		HA	.269	2.061
		BH	.040	.308
	.13	SR	-.198	-1.596
		HA	.258	2.077

Discussion

This contribution investigated the influence of different metacognitive learner characteristics on tool use. Increased tool use was hypothesized to occur in case of higher engagement in self-regulation activities, lower help seeking avoidance, higher beliefs in beneficial effects of help seeking behavior, and higher conceived functionalities of tools. Surprisingly, none of these hypotheses could be confirmed, and the theoretical model was totally falsified. For the adaptive advice-group and the control group a good fitting model for frequency of tool use could not be found. Even worse, none of the theoretically relevant independent variables significantly contributed to the variance in the frequency of tool use. For the proportional time spent on tools, an almost significant effect was found of perceived benefits of help seeking in the adaptive advice-group. Interesting in this case is the sign of the beta-value. Apparently, the more students perceive help seeking as beneficial the less time they spent on the tools. The items in the scale may provide an explanation. All items in the scale on perceived benefits of help seeking relate to asking questions to the teacher or to peers. It looks that the more students are inclined to ask for help from humans, the less they are inclined to use support tools. Therefore, this result calls for a study in which this human-effect would be directly tested.

While for the adapted advice- and the control-group a significant model could not be retrieved, a significant model was found for the fixed advice-group. For frequency of tool use, the best model includes perceived benefits of help seeking, self-regulation activities and conceived functionality as independent variables. Interestingly, the signs of the independent variables' contributions are once more opposite to what was expected for the perceived benefits of help seeking and conceived functionality. The more students posses self-regulation skills and the less they perceive help seeking behavior and the tools as functional the more frequent they use these tools. Especially conceived functionality plays a significant role. A possible explanation could be that the advice given on the specific tools causes a conflict with students' own conceptions about why they would think these tools are functional to their own problem solving process. Peculiar is the significant positive correlation found in this group between students' self-regulation skills and their conceived functionality of tools. This positive correlation would suggest that the more students possess monitoring skills, the more they can see the functionalities of tools. However, in the retrieved model, self-regulation contributes positively to frequency of tool use, while conceived functionality contributes negatively. This result calls for more in-depth theoretical work on the relationship between self-regulation and tool use.

In any case, results for the control, adapted and fixed advice group reveal problems with respect to predicting actual study behavior based on self-reporting instruments only. As suggested by Winne (in press) detailed observations of actual student behavior through log-files may help to resolve a number of the issues involved.

In the fixed advice-group a fitting model was found for time spent on tools, including two of the four independent variables, namely self-regulation skills and help avoidance behavior. Once more, some unexpected results were found. The more students indicate to avoid help, the more time they spent on tools. The more students possess self-regulation skills, the less time they spent on tools. With respect to the help avoidance

behavior, a similar remark can be made as above with respect to the human-effect. In the questionnaire the items measuring help avoidance behavior were related to students' behavior in class. Students' who avoid asking for help in their class, may be more inclined to first look for help in the material at hand, in this case, the computer program and explore all possible information that is available. For that reason, they might have welcomed the advice that was systematically given every seven minutes. Looking at the literature on help-seeking (e.g., Newman, 1998), this indeed deals mainly with asking other humans for help. This form of help-seeking is probably a more complex behavior than merely consulting tools, involving not only cognitive aspects, but also motivational aspects (Newman, 1998). It has been found that asking for help is often seen as admitting ones failures (Valentine, 1993). Students' who hold this perception tend not to ask help from teachers, but more frequently consult informal resources (Keefer & Karabenick, 1998). Looking at tools as informal resource of help could explain the retrieved influence of avoidance of help seeking on tool use. Students who avoid asking help from teachers, try to find a solution in the tools, the informal resources.

Overall, the results reveal mixed results with respect to the influence of metacognitive variables on tool use. It remains however curious how the groups differ with respect to the models retrieved and the contribution of the different independent variables. It seems that depending on the presence and kind of advice, different learner characteristics play a role in the frequency of, and proportional time spent on tool use. Moreover, these student characteristics often contribute to tool use in an opposite way then was expected.

Conclusion

This study revealed that, even though for one group a significant model was found, a large percentage of variance in the dependent variables was not explained, indicating that there must be a number of additional variables that should be considered in order to explain frequency of and proportional time spent on tool use. While from a theoretical point of view metacognitive variables seem important to consider, others seems even more important. Clark, Howard and Early (in press) for instance, point to motivational aspects involved in solving complex problem solving. They state that motivation accounts for almost as much learning variance as cognitive aptitude. Motivation is defined as self-efficacy, emotional regulation and attribution of mistakes.

Additionally, rather than students' instructional conceptions, Aleven et al. (2003) suggest that students' epistemological beliefs may influence students' tool use. A preliminary indication that there may indeed be a relation between epistemological beliefs and tool use is provided by Hartley and Bendixen (2001). They indicate that, contrary to what they expected, significant positive correlations were found between naive epistemological beliefs and tool use. However, although significant, the correlations were rather low (<.300).

Furthermore, it may be wondered what the role is of prior knowledge. Prior knowledge has been shown to be an important predictor of learning results (Dochy & Alexander, 1995). Of course, in complex problem solving, the question becomes prior knowledge of what. Is it prior knowledge about the content of the problem, about problem solving, about the learning environment? The study calls therefore for a more systematic analysis of the different types of prior knowledge that may affect actual student behavior in OLEs.

The results of this study reveal that not only student characteristics are important variables to consider, but also instructional interventions. Apparently the instructional intervention, c.q., advice, can moderate the effect of student characteristics. This implies that the effect of an instructional intervention is not only moderated by student characteristics, but that the influence of specific student characteristics can also be moderated by a specific instructional intervention.

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Connecting Preparation to Practice: Student Teachers' Uses of Technology and Their Cooperating Teachers' Impact

Anna C. Clifford and Michael M. Grant
The University of Memphis

Abstract

The purpose of this study was to describe preservice teachers' experiences as they attempted to integrate technology into their student teaching experience. Furthermore, we explored the impact cooperating teachers have on preservice teachers during these field experiences. This study followed the experiences of eight preservice teachers from a liberal arts Christian university in the mid-south and their cooperating teachers during the fall of 2005. Data were gathered through self-report reflections, interviews and surveys. Results indicated preservice teachers were using technology to enhance lessons during their student teaching experience, their cooperating teachers' support did affect their use of technology and preservice teachers were able to identify barriers and enablers which influenced their use of technology for teaching and learning.

The purpose of this study was to examine experiences preservice teachers, at a private, liberal arts Christian university in the mid-south, encountered as they attempted to integrate technology in their student teaching. This study attempts to fill a gap in the literature by specifically exploring the support given by cooperating teachers as preservice teacher attempt to use technology in the classroom. This study will allow teacher educators to gain a better understanding of the range of challenges faced by preservice teachers, explore what effects the support of the cooperating teacher's has on the preservice teachers' training infrastructure, and empower preservice teachers to identify and deal with some of the barriers they may face, as they attempt to teach with technology.

Research Questions

This study was conducted to answer the following research questions:

RQ1: In what ways do preservice teachers use technology in teaching and learning, during the student teaching experience?
RQ2: In what ways do cooperating teachers support preservice teachers' uses of technology in the classroom?
RQ3: What are the enablers and barriers for preservice teachers to integrate technology?

Method

Design

With these questions, a qualitative approach to identify emerging themes or patterns across participants and overtime was needed. Qualitative data were collected to understand the preservice teachers' use of technology, to identify the cooperating teacher's means of support, and to recognize barriers the preservice teachers experienced, using a case study approach. Pseudonyms have been used throughout the manuscript. A case study approach provides an opportunity to examine the *uniqueness* and *commonality* of the persons being studied and provides a chance to look at the interactions within its context in detail (Patton, 2002).

Setting and Participants

The study began with nineteen preservice teachers and their cooperating teachers from a private, liberal arts Christian university in the mid-south enrolled in student teaching in the fall of 2005. The preservice teachers had similar technology training and experiences, but their school placements and their cooperating teachers' backgrounds and experience were very diverse. Therefore, purposeful, heterogeneous sampling was used (Patton, 2002). The preservice teachers were seeking state licensure in early childhood, elementary, middle school, high school, Teaching English as the Second Language (TESL) and special education. Eight of these nineteen volunteered to participate in the study. Their respective cooperating teachers agreed to participate, as well. The licensure areas represented were elementary, middle school, TESL and special education. The preservice teachers were all white, Caucasian females whose ages ranged from 21 years to 43 years with a average age of 25 years. The cooperating teachers were employees of the local or nearby school districts. The cooperating teachers were all female Caucasians whose ages varied from 31 to 57 years with a mean of 43 years. Many of the cooperating teachers were considered veteran teachers. Their years of teaching ranged from five years to 27 years with a mean of 17 years.

Instrumentation

Instruments used to collect data for the study included a weekly reflection, interviews and two surveys. Each of these is described below.

Reflections. The reflection guide highlighted the specific technologies the preservice teachers used each week. Specifically, the preservice teacher were asked to identify whether they had used production tools, authoring tools, concept mapping applications, individualized tracking, and additional technologies (e.g., overhead projector, TV-VCR or DVD, scanner, SmartBoard, digital camera, other). For each technology used, the preservice teacher was asked to identify (a) where the technology-integrated lesson occurred (computer lab or with classroom computers) and (b) the pedagogical style of the lesson (teacher-directed or student-centered). In addition for each technology used, the preservice teacher was asked for a brief overview and any comments. After the first week, the reflection guide was modified, to distinguish between the teacher directed use of technology by the preservice teacher and the cooperating teacher.

Interviews. Focus group interviews were used so that the participants could hear each other's responses and make additional comments beyond their original response based upon what others had to say. The interviews were scheduled for approximately an hour. The semi-structured interviews focused on the guiding interview questions that were aligned with the three research questions. The focus group interviews were audio/video taped and transcribed verbatim. The researcher made reflection notes as a part of the process. Five preservice teachers participated in the focus group interview. Because of their schedules and travel distances, one preservice teacher participated in an individual interview and two preservice teachers chose not to participate. Another focus group interview was scheduled for the cooperating teachers. Three cooperating teachers participated in the focus group interview. Two cooperating teachers participated in individual phone interviews, and a third participated in a face to face interview in her classroom, during the same week.

Surveys. Two surveys were used with both the preservice teachers and the cooperating teachers. The Teacher Technology Questionnaire (Lowther & Ross, 2000) is a three-part instrument used to collect teacher perceptions of computers and technology. Only the first section was used with this research. In the first section, teachers rate their level of agreement with 20 statements regarding five technology-related areas: *Impact on Classroom Instruction, Impact on Students, Teacher Readiness to Integrate Technology, Overall Support for Technology in the School,* and *Technical Support*. Items are rated with a five-point Likert-type scale that ranges from (1) Strongly Disagree to (5) Strongly Agree. Two primary questions are asked in the second section. The first asks teachers to rate their level of computer ability as very good, good, moderate, poor, or no ability. Next, teachers indicate if they have a home computer, and if they do, if they use the home computer to access instructional materials on the Internet and/or to prepare classroom materials. The Technology Skills Assessment (TSA) (Marvin *et al.*, 2002) includes 50 three-point Likert-type questions. The three-point questions are designed to assess the perceived technological abilities of the participants. All of the questions are arranged into seven categories, which are aligned to the International Society for Technology in Education's (ISTE's) National Educational Technology Standards (NETS) (Marvin, Lowther & Ross, 2002b). The categories of the survey are as follows*: Computer Basics*, *Software Basics*, *Multimedia Basics, Internet Basics*, *Advanced Skills*, *Using Technology for Learning*, and *Policy and Ethics*. An additional section of the TSA that was not used in this research uses 6 multiple-choice questions designed to determine the actual knowledge of the participants on several areas of technological literacy also aligned with NETS.

Data Anaylsis

Qualitative data analysis. The qualitative data (i.e.., in-depth notes, reflections, interview transcripts) were analyzed using constant comparison and inductive analysis (LeCompte & Preissle, 1993) to guide the development of patterns and themes in the data. The first round in abstraction and data reduction began with manually sorting according to themes and open coding (Patton, 2002), based on commonly occurring words and phrases. Next, since the guided interview questions were aligned with the three research questions, the underlying themes (e.g., the preservice teacher use of technology in the student teaching experience) were exposed, thus *a priori* codes were applied to the data. Member checking, audit trail, peer debriefing and triangulation (Cresswell, 2003) were used to ensure trustworthiness.

Quantitative data analysis. The quantitative data were gathered from the Technology Teacher Questionnaire and Technology Skills Assessment. An error was found in the TTQ, a question was repeated in two constructs. The question was removed from the constructs. An independent t-test was conducted to test the significance of the means between the preservice teachers and cooperating teachers for each item and then for each construct. With the large number of t-tests conducted, a Bonferroni adjustment was added. For the TTQ, the significance level was set to $p<.002$ ($\alpha=.05/20$), and for the TSA the significance level was set to $p<.001$ ($\alpha=.05/47$).

Results

To best represent these mixed method findings, the qualitative themes are only listed below without the thick descriptions. Next, the quantitative results from the two surveys are reported with their inferential and descriptive statistics. Then to situate these findings, the results as a whole are interpreted together in the following section with support from the qualitative and quantitative data, where the voices of the participants are presented.

The underlying qualitative themes included: (1) use of technology, (2) cooperating teachers' actual support, and (3) barriers and enablers experienced. Again, these three themes were based upon the research questions. The additional themes that emerged from the data included: (4) expectations for the use of technology and (5) technology guidelines.

Surveys

TTQ. The TTQ acknowledges the participants' perception of technology. An independent-samples t-test compared the mean scores of the preservice teachers and the cooperating teachers using the TTQ. The mean and standard deviation were derived for each question and for each of the five constructs (i.e., *Impact on Classroom Instruction, Impact on Students, Teacher Readiness to Integrate Technology, Overall Support for Technology in the School, and Technical Support).* Both the means and standard deviations for the preservice teachers and the cooperating teachers were calculated for comparison. Results indicated there was no significant statistical difference in the responses of the two groups on the individual questions.

Interestingly, the mean (M=4.13) from both groups was the same on Question 12: My computer skills are adequate to conduct classes that have students using technology, thus the participants felt their computer skills were adequate to conduct classes that have students using technology. The greatest difference in the means was on Question 2: I can readily obtain answers to technology-related questions. The preservice teachers mean (M=3.38, SD=.744) much higher than the cooperating teachers mean (M=2.38, SD=1.188), indicated that the preservice teachers felt confident they could readily obtain answers to technology related questions. No statistical significance, however, was found.

When the mean scores and standard deviations were derived for the five constructs, there was no statistical significance in the means of the preservice teachers and the cooperating teachers reflected on the TTQ in any of the constructs.

TSA. The TSA revealed levels of confidence in the preservice teachers and the cooperating teachers' use of technology. An independent t-test compared the mean scores of the preservice teachers and the cooperating teachers on each question, as well as for on each of the six constructs (i.e., *Computer Basics, Software Basics, Multimedia Basics, Internet Basics, Advanced Skills, and Using Technology for Learning*). When the mean scores of the participants were compared on each of the 46 questions, there was a significant statistical difference on 1 of the 47 questions. The mean and the standard deviation for Question 2: "Create basic computer documents (word processed) in a timely manner?" and Question 11: "Print a document using "Print" form the File menu and/or the toolbar icon?" were the same for both groups.

With each of the grouped constructs, the preservice teachers' means were higher than the cooperating teachers' means in every section. No significant differences were found with the constructs, however.

Findings and Interpretations

Three underlying themes based upon the research questions and guided by the interview questions and two additional themes emerged from the focus group and individual interviews with the preservice teachers and the cooperating teachers signaling issues that seem to affect preservice teachers' integration of technology in the classroom during their student teaching experience.

The underlying themes included: (1) use of technology, (2) cooperating teachers' actual support, and (3) barriers and enablers experienced. Again, these three themes were based upon the research questions. The additional themes that emerged from the data, included: (4) expectations for the use of technology and (5) technology guidelines. Each of the five themes will be discussed in the section below and supported direct quotes from participants.

Preservice Teachers Use of Technology in the Student Teaching Experience

The first theme examined the preservice teachers' actual use of technology in teaching and learning during the ten-week period. As the preservice teachers completed their reflections and their interview, the findings indicated all eight of the preservice teachers had access to technology. They used technology on a personal basis (e.g., e-mail, writing lesson plans) and all of the preservice teachers were able to use technology in the classroom in one form or another.

The findings of the present study were consistent with Grove, Strudler, and Odell's (2004) report that classrooms teachers had access to technology. However, all of the current preservice teachers who participated in this study utilized technology in contrast to Grove, Strudler, and Odell's report that less than one-half of preservice teachers used technology in their student teaching experiences.

The results of the self-reflections indicated all of the preservice teachers used software as production tools (e.g., Microsoft Word and PowerPoint) and individualized tracked application (e.g., Milliken Math, Accelerator Reader, Cornerstone McGraw Hill Reading, Arthur Readings). Both the preservice teachers and the cooperating teachers reported the use of other technologies (e.g., Leap Pads, PlayStation, overhead projectors, VCR/DVD players, tape recorders,

Smart Boards, laserdiscs, digital cameras and interactive student response clickers). Authoring tools and concept mapping were not used by either of the groups of participants. In addition, the Internet was used on a regular basis for both teacher and student research and two preservice teachers and cooperating teachers mentioned integrating Internet-based digital video and developing WebQuests into the teaching and learning process.

From their feedback and questions, this was the first time some had really thought about how the use of technology was actually implemented: teacher-directed or student-centered. Their understanding of the difference in teacher-directed and student-centered use of technology was a bit vague. All five of the preservice teachers felt they were using technology in the classroom in both ways. Ayn said, "We make the things we use, but it's the students who are interacting with them. I develop manipulatives using the computers, print them out, laminate, and that way the students have their hands on activities kind of an indirect way that the students have access to the technology." The involvement she talked about was using the end product (e.g., completing a teacher computer generated worksheet). Was this an example of both teacher-directed and student-centered? After some discussion, the group agreed perhaps development of the materials and giving them to the students is still teacher-directed. The use of technology was teacher- directed, but the activity was student focused. They were trying to sort meanings, within their experiences.

Teacher-directed. According to Wang, (2002), teacher-directed computer usage was defined as teachers using computers to: (1) create instructional materials, (2) find resources, (3) communicate with others, (4) keep track of students' grades, (5) present information to the whole class, and (6) provide computer enrichment activity. Six of the eight preservice teachers and cooperating teachers recalled using a number of PowerPoint presentations, gathering research from the Internet, sharing it with the students, creating manipulatives for student learning and creating transparencies to use with the overhead projector.

Student-centered. In contrast, student-centered computer usage was defined as students using computers to (1) create learning resources, (2) find resources for learning activities, (3) communicate with others, (4) present information, (5) complete class projects, and (6) engage in more hands-on learning activities (Wang, 2002). Therefore, student-centered technology empowers the student. The preservice teachers' understanding of this definition was not always consistent. The K-12 students were actively involved in the use of technology independently (e.g.,development of crossword puzzles, creating electronic presentations or research on the Internet). One of the preservice teachers, Caryn, explained when her children were using the individualized tracking software, the students worked independently. These words triggered the student-centered mode for her. "They know how to do it. They know exactly what to do, in certain areas." Gayle mentioned her students used educational software called *Arthur's Reading* during reading time. The software read the words aloud to the children. Some of the children used the Paint program, as well. "They created and painted a picture and they enjoyed that." As the preservice teachers continued sharing their thoughts on student-centered use of technology, one "had a child who had trouble writing and expressing his thoughts on paper, so when [the class] had our practice writing time, he would tape. He would talk and record his story onto the tape."

Rae shared her eight graders were not very self-directed because they were used to being told what to do, and how to do. They "freeze up" when it is their time. [Preservice teacher and cooperating teacher] have "taken baby steps with them and they now know just what to do." According to the results of the TSA, the preservice teachers and the cooperating teachers have a basic working knowledge of computers, software and the Internet. The means for the sections *Computer Basics*, *Software Basics* and *Internet Basics* fell within the range of 2 (Somewhat) to 3 (Very Easily) in all three areas.

The section *Teacher Readiness to Integrate Technology* on the TTQ received the highest means from both groups: preservice teachers (M=4.16, SD=.421) and cooperating teachers (M=4.00, SD=.354). The section *Advanced Skills* earned the lowest means in both groups: preservice teachers (M=1.76, DS=.333) and cooperating teachers (M=1.42, SD=.375). Therefore, preservice teachers and cooperating teachers felt they were adequately prepared and had sufficient support to integrate technology into their teaching using, basic computer, software and the Internet, but did not have the more advanced skills (e.g., use advance computer terms publish info in a variety of media, determine software-operating system compatibility).

The results of the section *Using Technology for Learning* includes: preservice teachers (M=2.25, SD=.185) and the cooperating teachers (M=1.71, SD=.470). This is the only construct with a statistical significant difference. The difference in the means of Question 45: "Create and electronic teaching portfolio to evaluate your work." for the preservice teachers (M= 2.38, SD=.518) and cooperating teachers (M=1.25, SD=.463) was of particularly interest. The preservice teachers noted this was the first semester they were required to generate both an electronic professional portfolio and an electronic student teaching portfolio.

These results align with other researchers concluding preservice teachers and cooperating teachers are using technology in the classroom, to some degree. In most of these classrooms, the use of technology is associated with teacher-directed practices and only replaced or improved traditional instruction. Teacher-directed use of technology is consider a lower-level use of technology, when it is compared to student-centered use of technology (Ertmer, 2005).

Cooperating Teachers' Support of Preservice Teachers' Uses of Technology

The second theme addresses the effects cooperating teachers have on preservice teachers' use of technology during the student teaching experience. The preservice teachers agreed with Bullock (2004), Grove *et al*., (2004) and Stevenson (2005). The cooperating teachers do make a real impact upon whether or not technology is used for teaching and learning. The preservice teachers acknowledged the support, or lack of support, they felt from the cooperating teachers. The relationship was reciprocal, too. Both of these views are discussed below.

Cooperating Teachers' Impact. Rae shared her cooperating teacher constantly encouraged her, "Are you comfortable with this? Do you feel OK doing this?" There were new things (e.g., using laserdiscs) Rae had not had any experience with and she was nervous about using these things with the students. Rae would practice using them with her cooperating teacher by her side, until she felt ready to teach using these tools.

Gayle did not think her cooperating teacher used technology very much, if at all, before she arrived. As they talked and worked together, Gayle shared some of her own technology ideas and experiences. The cooperating teacher's response was, "You know, I would like to try that," and she began talking with other teachers in first grade about possibilities for integrating technology. The cooperating teacher learned that another first grade teacher had created and was using electronic presentations in reading. This news challenged her and encouraged her to begin to create presentations on her own.

Heidi and her cooperating teacher floated between two different schools Teaching English as the Second Language. They were working on a new closet-classroom for their students to use in one of the school. Heidi had helped her cooperating teacher remove some old computers from the discard pile, with hopes of having more computers for the TESL students to use word processing. Heidi's cooperating teacher indicated these students did not have access to computers at home and loved to use the word-processing software. Heidi helped her network them to a confiscated printer, as well. Heidi mentioned the paperwork for ESL teachers. There was not a working electronic record system in place. She and her cooperating teacher appeared to be very frustrated because the school district had purchased them new laptops to transition from the paper record system to an electronic record system and they had run into several barriers.

On the other hand, there were times the cooperating teacher did not seem as supportive and appeared as a barrier when the use of technology was the focus. Gayle voiced, "There have been times when I would have liked to use an overhead, but my cooperating teacher doesn't have one because she doesn't like to use one. So because of that I just write it on the board."

One preservice teacher mentioned that her school was filled with technology but she had difficulty in finding what was available and where it was hiding. Oftentimes her cooperating teacher would suggest that she try specific means to integrate technology (e.g., United Streaming) and she had no idea they were available. Her cooperating teachers shared with her a little at a time. She concluded, "with her not being very excited herself about using [technology], she just doesn't think about telling me."

Reciprocal Relationships. While the cooperating teacher had a tremendous influence on the preservice teachers, the relationship was reciprocal. Echoing the reviews and findings of (Butler & Wiebe, 2003), the preservice teachers and the cooperating teachers felt they had exchanged teaching and learning (e.g., using voiceover in Microsoft PowerPoint, developing teaching stragtegies using of laptops computers, designing Web Quests, working in another platform) with each other.

The results of the TTQ indicated both groups agreed technology does have a positive impact on classroom instruction and student learning. The results of the section *Impact on Classroom Instruction* included: the preservice teachers (M=3.69, SD= .372) and the cooperating teachers (M=3.78, SD=.920) . The results of the section *Impact on Students* included: the preservice teachers (M=3.87, SD= .352) and the cooperating teachers (M=4.2, SD=.754). Thus, both groups agree they use technology on a regular basis, the use of technology encourages student-center learning and the use of technology improves the quality of student work.

In the section *Overall Support for Technology in the School* the mean is replicated, with the preservice teachers (M=3.34, SD= .626) and the cooperating teachers (M=3.34, SD=.823). This constructs included Question 17 “Teachers in this school are generally supportive of technology integration efforts” and included the support given by and perceived by the cooperating teacher.

Thus, the participants agreed that technology does definitely have a positive impact of classroom instruction and students’ learning and teachers within the learning environment support the use of technology.

Barriers/Enablers Preservice Teachers Face as they Attempt to Use Technology

The third theme identified common barriers or obstacles and enablers as perceived by the preservice teachers. The preservice teachers encountered a number of barriers and enabling factors as they attempted to teach using technology during their student teaching experience.

Barriers

The results of the interviews support the literature (Collier *et al*., 2004; Ertmer, 1999; Evans & Gunter, 2004; Iding *et al*., 2002; Persichitte *et al*., 2003; Stuhlmann & Taylor, 1999; Williams, 2003) which explored intrinsic barriers confronted by preservice teachers who attempt to teach with technology. Gayle voiced it was up to her to find ways to use technology. She found herself constantly thinking about how she could integrate technology into teaching: “So it's up to me to think!”

Rae had experienced writing lesson plans with a technology component in her teacher education program. She said it looked good on paper. She never attempted to teach one of those plans to “real students. Rae was afraid. It was tough!” She shared as she moved into the student teaching with determination and coupled with a technology-savvy cooperating teacher, she overcame some of the fear and was successful.

The participants easily identified extrinsic barriers during their experiences, and some were able to find workable solutions. Others reconciled that the students were not missing out on instruction due to a lack of resources. Each of these extrinsic barriers, (a) lack of preparation, (b) lack of equipment, (c) reconciliation, (d) lack of autonomy, and (e) lack of support are discussed below.

Lack of preparation. One preservice teacher discussed her prior use of technology in teaching. She did not feel comfortable teaching with technology, knowing that so many things could go wrong in the front of thirty students and so many computers. She was comfortable with using technology but not teaching with technology.

Lack of equipment. Three of the eight preservice teachers indicated the computers were “very old and out of date” and “we just don't always have the resources to use them in our classroom.” Brooke singled out the fact their library of software oftentimes would not run on the classroom computers. Heidi mentioned making sure you have all your necessary equipment there: “For instance, the other day I had planned to use the overhead and realized we didn't have an extension cord that could plug into the wall, and so we had to scrap that and go for working on the board.”

Reconciliation. Two preservice teachers and one of the cooperating teachers indicated the children were not missing out on learning. Heidi, elaborating on the nature of Teaching English as the Second Language (TESL), felt they received whatever equipment anyone else did not need. She described her classrooms as “large closets” with the “left over pieces of disjointed computers” and very few resources. She alluded to the fact she is working on a scheduled time for her students to go to the computer lab, “a way to overcome the lack of resources.”

The Special Education and TESL preservice teachers explained that the structure of the small groups and one-on-one teaching were benefits in their respective classrooms, which gave them compensation for the lack of use of technology. Ayn concluded, “a computer would be nice, but we really don’t have much room.” A cooperating teacher confirmed, “I don't really think the children are losing out on anything.” There again, “they do have the computer class once a week, and that at least introduces them to the other aspects of the computer, so they're not totally illiterate about it.”

And yet according to the TTQ, the mean scores for *Impact on Students* were between (3) *Neither Agree or Disagree* and (4) *Agree*. The preservice teachers (M=3.82, SD=.352) and the cooperating teachers (M=4.2, SD=.754) closely agreed technology does have a positive *Impact on Students’* levels of interaction, student learning and achievement and has improved the quality of students’ work. So, it appears that the teachers may value the impact of technology, but barriers prevent them from making the most effective uses of technology.

Lack of autonomy. Caryn cited they could only use the good computers in the classroom for Accelerated Reader. Heidi, with frustration in her voice, made mention of the fact the school system had just purchased laptops for the Teaching English as the Second Language teachers to keep track of the students in different schools. They were excited about the laptops, but because of the firewall, teachers were only able to log into their assigned (one) school. She and her cooperating teacher served two different schools. “I tried to make it so that we could print

straight off of the laptop," Caryn said. "I tried to install the software and couldn't do it." She indicated she had requested help from the school district's technology coordinator and was waiting for a response.

Lack of support. The participants aired voices of concern as they talked about specific people who had been, or who had not been, identified in their schools as technology savvy. Brooke saw no organized framework within the school she could go to for assistance or trouble shooting. She question if there was "a team of people that even think about using technology, or are excited about it, or who even know how to do it" and felt very little encouragement about using technology just from the people at this school.

Oddly enough, Rae could identify several sources for assistance. "There is a student that is quite gifted. In fact, they pull him out of class on a regular basis to help troubleshoot all over school—sixth, seventh, and eighth grade—and he loves it. That's his area, and it's a privilege for him to get to go and do that kind of thing." And tech-savvy teachers are assigned as troubleshooters, in particular areas.

Cooperating teachers agreed with the voices of their preservice teachers; they did need an easy accessible and knowledgeable technology contact person . One spoke of her school having two teachers (e.g., sports coach and classroom teacher) assigned as computer assistants. It was difficult to connect with the coach, but the classroom teacher was available most of the time. The process for the more difficult troubleshooting entailed a work order sent to the central office and a wait time. A similar situation was reflected by another cooperating teacher, but the funding for the computer coach was cut. She could not think of anyone else to go to for technology assistance.

The TTQ indicated the means for the section called *Overall Support for Technology in the School* were the same for the preservice teachers (M=3.34, SD=0.85) and the cooperating teachers (M=3.34 , SD=.823), with (3) Neither Agree or Disagree and (4) Agree. The participants agreed to some support for technology in their schools was in place. Interestingly, the preservice teachers (M= 3.22, SD=.891) perceived more *Technical Support,* than did the cooperating teachers (M=2.84, SD=.823). To a much stronger degree, the preservice teachers perceived the computers were kept in good working condition, they could easily access answers to technology related questions, their students have access to updates technology resource and materials and materials (e.g., software, printer supplies) for classroom are readily accessible

Lack of preparation time. The preservice teachers agreed it takes a lot of time and effort up front for a teacher to sit down and use technology, Rae said, "It takes forever to create a WebQuest!" Another added using technology took up class time. "We have so many skills to teach them. I'd love to teach them how to do PowerPoint presentations, because I was so excited when I finally learned how to do it, and how beneficial it is to me. There is not time!"

Enablers

Once the barriers were set aside, immediately the preservice teachers focused on factors encouraging them to use technology for teaching and learning. In many cases these were the barriers in reverse. These included: people support and environmental support.

People support. Rae and her cooperating teacher concluded student feedback would be the strongest enabler. "They're excited when we say we are going to go out to the computers today and work. They hate when we make them come back in because they're not doing what they're supposed to be." Caryn, Gayle and Brooke agreed that student feedback would be the strongest enabler for them, too.

Gayle, older that the other preservice teachers, felt she did not have the high school experience in technology but "I feel I am prepared to use technology, with my limited background when I came here. I'm not afraid to go try to learn something. I might not understand it, but I'm not afraid to try!" In contrast, she shared her cooperating teacher was scared to death when she hears computer conference or something like that. "I feel well prepared and not afraid at all."

Booke mentioned she had an outside source who encouraged her and "got her mind to thinking more about using technology." She shared she felt like the cooperating teacher let them use it "really on my on account that I starting doing small groups for technology and a lot of that is my own technology skills." She says she is "proactive."

Environmental support. Preservice teachers felt support from websites, *easy* access to the computers and scheduling.

In two cases, the preservice teachers described the user friendliness (e.g., creation of specific address books and distributions lists) of the school's website. It served as an important tool for communications between the home and school. Information was updated often as events evolved in the school's community, as well as access to email accounts. Uploading students' academic records and grades is forthcoming.

Rae, her cooperating teacher and Caryn suggested easy access to technology. For them, a number of computers were available to them either in the classroom, in the hall adjacent to the classroom or in an easy accessible computer lab. The ongoing availability of the computers encouraged the preservice teachers and the cooperating teachers to plan for and integrate technology daily. Rae's cooperating teachers said. "They are just

sitting there ready to be used. I just have to signup for them." Rae felt the longer periods (ninety minutes) of time gave the students time to actually "get into the assignment with a technology component. Rae and her cooperating teacher agreed their school environment nurtured their technology interest.

Expectations for the Use of Technology as Perceived by the Preservice Teachers

The fourth theme described how preservice teachers perceived the expectations for the use of technology as required by the teacher education program. Preservice teachers have had similar technology training as required by the teacher education program at the university. They have successfully completed a micro-computing course and an instructional technology course. The micro-computing course addressed the applications of Microsoft Office and Front Page. It is a prerequisite for the instructional technology course. The instructional technology course attempted to extend their working knowledge and application of Microsoft Word, PowerPoint, Excel, Front Page, and HyperStudio, engaging the preservice teachers in both teacher-directed and student-focused activities to integrate into the classroom. This is aligned to meet the current technology standards set by NCATE (National Council for Accreditation of Teacher Education, 2003). In an attempt to require preservice teachers to use and to build upon their technology skills, there are planned strands of technology integration in the required coursework throughout the six teacher preparation courses, as preservice teachers developed lesson plans and taught within a simulated environment or within a practicum experience.

The preservice teachers all agreed that they did not feel the use of technology was actually required as a part of their student teaching experience and alluded that it was really never a topic of conversation with their university's student teacher supervisor. Ayn, Heidi, Gayle and Caryn agreed technology was not directly discussed with the university supervisor, yet felt technology was expected. Ayn implied when she computer-generated manipulatives and handouts, the [university student teacher supervisor] always talked about how professional looking they were.

It was not clear as to whether or not the preservice teachers were actually required to have technology as a component in the lesson planning and process, during their student teaching practicum. The preservice teachers agreed that technology made a positive impact on the classroom and on students' learning and all attempted to use technology on a routine basis, as they had been taught.

Guidelines for Successful Integration of Technology

The final theme explores the preservice teachers' guidelines deemed necessary to be successful in teaching with technology in the classroom. As the preservice teachers reflected on their attempts to use technology in the classroom, all of them echoed components to a *must do* list in order to teach with technology, successfully. Their lists was based upon their knowledge and their experiences and included (a) allowing for peer interaction and collaboration, (b) allowing time for the students to practice technology skills, (c)using technology as another tool for teaching and learning, (d) focusing on the classroom management issues, (e) being flexible and (f) understanding the use of technology is not for all lessons ,but any lesson that could be enhanced with technology should be (Mims, 2004).

The preservice teachers agreed teaching with technology was much more than just learning how to use technology. It involved change from traditional teaching. The preservice teachers were not able to readily identify the changes but much of their discussion centered on individuals. Interesting enough, an effective use of technology integration is student-centered, where students construct their own knowledge (Jonassen, 1991; Nanjappa & Grant, 2003).

Implications

This study was designed to explore preservice teachers' experiences as they attempted to integrate technology during the student teaching experience. The implications of this research are informative to teacher educators as they seek to prepare preservice teachers, as well as novice and inservice teachers as they prepare themselves to use technology for student-centered learning.

First, the preservice teacher and the cooperating teachers in this study were using technology on a daily basis. They agreed technology made a positive impact students' learning. and teaching was more student-centered when technology was used. Although, their discussion on teacher-directed and student-centered teaching revealed a shady understanding of the concepts for preservice teachers, it caused them to reflect. They could easily explain teacher-directed learning and connected it with the way they had been taught. It was difficult for them to define and give an example of student-centered learning. At a point, the discussion led to the scenario of a teacher making a computer generated worksheet and giving it to a student to complete or teaching a student how to use AR independently. A broader sense of empowering the students to develop using technology surfaced from the discussion. The preservice teachers reflected over their student teaching experiences and identified times they felt

they empowered their students to `design and to develop. Their responses included students' developed WebQuest, created PowerPoints with voice-over, and generating a spelling test.

Prior studies (Beyerbach & Walsh, 2001; Collier *et al*., 2004; Seels *et al*., 2003) noted preservice teachers tended to teach as they were taught and oftentimes this was teacher-directed. Preservice teachers must shift their thinking of technology integration from thinking they would teach and learn about technology to using technology to support student learning. There has been a noticeable shift in preservice teachers' thought process when teacher educators required a technology integration component, scaffold higher levels of technology integration into the require coursework, and build on a more focused and comprehensive use of technology (e.g., electronic portfolios) (Wright & Wilson, 2005).

Second, cooperating teachers and the student teaching experience are integral parts of teacher education training. In addition, while the cooperating teachers are considered mentors to the preservice teachers, it is evident from this study and others (Bullock, 2004; Lane *et al.*, 2003; Margerum-Leys, 2004) that preservice teachers and cooperating teachers tap into each others' curricular, pedagogical and technological knowledge. In this study, the preservice teachers perceived the student teaching practicum as being a positive, professional experience, supported by the cooperating teachers.

In this study, when cooperating teachers were actually using technology on regular basic, preservice teachers would follow suit, regardless of the level of usage. Early on, it appeared that the preservice teachers were trying to duplicate its use, but later in the experiences some of them were trying to think outside the box and carry the integration a step farther. Interesting too, when the preservice teachers did not experience tech-savvy cooperating teachers, they met the challenged with force and self-motivation and found avenues to integrate technology in their teaching. None of the preservice teachers sat idling with technology.

Preservice teachers were stimulated by attending technology workshops with their cooperating and connecting with veteran tech-savvy teachers who were willing to talk infusion of technology experiences. They were inspired when they saw computers being lifted from the garbage pile and soon becoming the tool used by TESC for expressing the English language. They connected when cooperating teachers brought in their own personal laptop for students to experience assistive technology effectively. They connected with cooperating teachers who brainstormed troubleshooting, as well as new ideas of technology integration and encouraged them to take the next step. They were open to learning new technology capabilities and instructional design, as it was scaffold into their learning process, allowing time for practice and the development of its use in their teaching.

On several occasions, the results from this study revealed the cooperating teachers served as barriers for technology integration. The preservice teachers mentioned the cooperating teacher had forgotten to tell her about the availability of some technology (e.g., United Streaming), or the cooperating teachers expected the preservice teacher to learn how to use the technology and then teach the cooperating teacher. A preservice teacher reported she was not able to use her presentations because the classroom computer would not open them. The cooperating teacher encouraged her to use the overhead. In another classroom room, the computer center had been closed for sometime and the preservice teacher was told that the students go to the computer lab for their technology.

As in this study and others (Bullock, 2004; Doering *et al*., 2003a; Doering *et al.*, 2003b; Lane *et al*., 2003) the cooperating teachers acted at times as an enabler and a disabler as preservice teachers were attempting to teach with technology. Obviously, the enabling situations set a positive stage for success. How do the preservice teachers respond to these barriers? More work is needed for this areas, even though current studies (Lane *et al*., 2003; Pierson & McLachlan, 2004) suggested the barriers serve as a driving force to push the preservice teacher cope with or overcome the proposed barrier established by the cooperating teachers or the preservice teachers are set up as change agents within the teaching-learning experience.

Third, additional barriers and enablers faced by those who attempt to integrate technology are consistent with both preservice teachers and cooperating teachers (Brush *et al*., 2003; Ertmer, 1999, 2003). In this study, participants identified both intrinsic barriers (e.g., lack of perseverance, lack of motivation) and extrinsic barriers (e.g., lack of time, lack of support). Similar barriers were identified in much earlier studies, as well (Ertmer, 1999) This studied indicated there were times the preservice teacher became frustrated, as they faced the barriers not knowing exactly what to do. In addition, preservice teachers should be made aware of the potential enablers available to them. The participants in this study made use of both people support (e.g., students and cooperating teacher) and environment support (e.g., adequate equipment and adequate technical support). Preservice teachers should learn how to maximum the power of the enablers, work with the disablers, perhaps even turning them into enablers. Bullock (2004) suggested that perhaps the near future would bring about a model for teacher educators that encourage preservice teachers to see the factors they encounter as enablers rather than disablers and better preparing them as technology using educators.

Conclusion

Preservice teachers are an important means by which technology is introduced into students' learning experience (Evans & Gunter, 2004).Their training throughout the teacher preparation program must align, reflect and achieve the most current educational goals, which includes the use of technology for teaching and learning. From the results of this study, preservice teachers and the cooperating teachers feel they are adequately trained and are capable of integrating technology into their teaching and learning experiences. Both groups are readily using a variety of technology in the classroom and are slowly making the transition from teacher-directed uses of technology to student-centered uses of technology. The cooperating teachers' support or lack of support impacts the preservice teachers' uses of technology. Thus, enabling the preservice teachers to tackle barriers (e.g., lack of autonomy) and recognize enablers (e.g., the students), as learning takes place for the students, the preservice teacher and the cooperating teacher during the culminating student teaching practicum.

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The impact of the total learning environment on the effects of a digital learning environment: how the teacher affects the effects of a pedagogical agent

Sigrid François
Centrum voor Taal en onderwijs

Jan Elen
Geraldine Clarebout
Centre for Instructional Psychology and Technology

From a socio-constructivist perspective on learning and instruction, an exclusive research focus on the effects as such of pedagogical agents on learning can be questioned. Indeed, learning happens in a socio-cultural environment that as a whole affects learning processes. In order to understand better the impact of that socio-cultural environment, this study investigates whether contextual features, or features of the total learning environment, affect the pedagogical agents' effect on learning.

The literature contains several definitions of pedagogical agents (Craig & Gholson, 2002; Johnson, Shaw & Ganeshan, 1998; Suraweera, 1999). Four main features seem to be recurrent. First, pedagogical agents are animated characters, i.e. living personas. Second, pedagogical agents have different roles and functions, all of which are targeted to support students' learning. Clarebout, Elen, Johnson, and Shaw (2002) proposed a support-typology that can be used to describe these roles and functions. The typology considers six aspects of an agent's support: the object of support, learner control, adaptability, style, timing, and delivery modalities. Third, pedagogical agents interact with students: they react to students' actions. And finally, these lifelike agents are part of the digital component of a more encompassing learning environment.

Gommer, van Geloven, Jansen, and Zeelenberg (2000) describe the total learning environment as the totality of means, strategies, persons and facilities that make learning possible. Students learn through interaction with this learning environment. Traditionally, such a learning environment consists of the teacher, peers, teaching materials and other sources of information, the physical environment in which students are active, and means such as paper, pencils, etc. According to these authors, the digital component of a learning environment is that part of the total learning environment that is supported by information and communication technology (ICT). Given that pedagogical agents are part of a digital learning environment, they are at the same time also part of the more extensive, total learning environment. Suraweera (1999), for instance, describes pedagogical agents as being part of a digital learning environment, which in turn is part of a total, more encompassing learning environment.

Research on pedagogical agents has recently attracted much attention (e.g. Baylor & Ebbers, 2003; Conati & Zhao, 2004; Clarebout & Elen, 2005, in press; Johnson, Rickel & Lester, 2000; Lester, Converse, Kahler, Barlow, Stone & Bhogal, 1997; Lester, Voerman, Towns & Callaway, 1997; Lester, Towns & Fitzgerald, 1999; Lester, Zettlemoyer, Grégoire & Bares, 1999; Mayer, Heiser & Lonn, 2001; Moreno, 2004; Moreno & Mayer, 2000a; Moreno & Mayer, 2000b; Moreno, Mayer & Lester, 2000; Moreno, Mayer, Spires & Lester, 2001; Okonkwo & Vassileva, 2001; Suraweera, 1999; Xiao, Stasko, & Catrambone, 2004). In this literature, two types of research questions have been addressed. A first question relates to pedagogical agents' impact on learning results. Research on the second question aims at identifying which of the agent's features are important. These questions, dealt with in the aforementioned studies, typically address the agent itself within the digital environment in which it resides. They do not consider the total learning environment, or in other words the context for this digital environment. This is a problem, as the importance of the total learning environment, or the context (e.g. the impact of the teacher, peers, etc.), can hardly be overstated from a socio-constructivist point of view on learning and instruction and with a concern for ecological valid research.

In this study, it is investigated whether a teacher's positive, neutral or negative introduction of a pedagogical agent to the learner affects the learner's use and perception of the pedagogical agent, and whether it has an (indirect) impact on learning results. Research suggests two conflicting results of such an introduction. On the one hand, in line with the media equation (Reeves & Nass, 1996), which postulates that interactions between humans and media are similar to those between humans and even more, "media equal real life" (p.6), one may doubt whether the teacher's introduction may change the pupil's opinion and use of the agent as the teacher is simply one other element. Consequently, such an introduction will also have no impact on the learning results attained with the support of the agent. On the other hand, studies in which the media equation is contradicted (e.g. Chiasson & Gutwin, 2005) lead to the opposing argument: pedagogical agents, however humanlike, will never be as credible as a human teacher. Because human teachers are more credible, it is most probable that their

introduction affects the learner's use and perception of the pedagogical agent, and even the learner's learning results. From this theoretical assumption an effect of the teacher's introduction is to be expected. More specifically, a larger, negative impact of a negative introduction is to be expected than a positive impact of a positive introduction. This specification is supported by research on the so-called *negativity effect* (De Bruin & Van Lange, 1999; Fiske, 1980; Hamilton & Zanna, 1972; Peeters & Czapinski, 1990; Reeder & Coovert, 1986; Richey, McClelland & Shimkunas, 1967): "a bias according to which evaluatively negative stimuli would have greater impact upon subjects than equally intense positive stimuli" (Peeters & Czapinski, 1990, p.55). Weinstein and Crowdus (1968) give two explanations for the observation that people tend to give more weight to negative information than to positive information. First, people expect normatively 'good' actions, so negative actions attract more attention because they deviate from that norm. Second, it is in their own benefit to give more attention to negative information: based on this information, people make predictions about the subject of the information. False-positive predictions are more harmful than false-negative predictions. Richey et al. (1967) give yet another explanation: they state that negative information is seen as more intrinsically true and honest.

Assuming the second group of research results is correct, four hypotheses were examined.
First, it is expected that learners who receive a positive introduction of a pedagogical agent, will listen more to what this agent tells than learners who get no introduction (neutral group). Learners who get a negative introduction of the agent, will listen less to the agent than learners who get no introduction (neutral group).
Second, it is hypothesized that learners who receive a positive introduction of a pedagogical agent, will obey this agent more than learners who get no introduction (neutral group). Learners to whom the agent is introduced negatively will obey this agent less than learners who get no introduction (neutral group).
Third, learners who receive a positive introduction of a pedagogical agent are expected to perceive this agent more positively than learners who get no introduction (neutral group). Learners, who get a negative introduction of the agent, are expected to perceive this agent less positively than learners who get no introduction (neutral group).
Fourth; assuming that being compliant with the advice of the agent is functional towards increasing learning results, learners who receive a positive introduction of a pedagogical agent, are hypothesized to do better on the posttest than learners who get no introduction (neutral group). Learners who get a negative introduction of the agent, will get lower scores on the posttest than learners who get no introduction (neutral group).

Methodology

Participants

Eighty-one 11 years old pupils participated. For practical reasons participants were recruited in schools that had a computer class at their disposal. In order to reduce class-effects each class was split into at least two groups which were randomly assigned to different conditions. Table 1 shows the distribution of the participants over the three conditions.

Table 1: *Sample*

	POS-group	NEG-group	NEU-group	TOTAL
School 1	6	0	6	12
School 2, class 1	0	7	7	14
School 2, class 2	0	8	7	15
School 3	10	0	10	20
School 4	10	10	0	20
TOTAL	26	25	30	81

Material and instruments

The digital learning environment

For the purpose of the study a pedagogical agent called the' *Garbage Bunny'* was used. This agent is part of a Flemish digital learning environment called 'Afval minderen voor kinderen' or '*Reducing waste for children'* (Ovam, 2003), which is intended to teach 4th to 7th graders about sorting waste and recycling. In *Reducing waste for children* learners can visit five different locations in a virtual school (e.g. the classroom, the refectory, the playground, etc.), in each of which they can explore several objects and learn about their features (Figure 1).

Figure 1: ‘The Garbage Bunny’ in the virtual school

The Garbage Bunny supports the learner throughout the whole program. Using the previously introduced support-typology (Clarebout et al., 2002), the Garbage Bunny can be described as follows. First, the Garbage Bunny has a coaching role. It guides the learner through the program, urges the learner to act, and provides hints for and feedback to test items. Second, its modality is mainly explaining: the agent explains (parts of) the program to the learner. Because the Garbage Bunny also asks questions now and then, his modality is questioning as well. Third, the object of its support includes problem solving steps, meta-cognitive aspects, feedback during the tests the learner can perform in the program, and technical issues. The agent offers no content-specific support. Fourth, most of its information is concurrently delivered orally and printed. Its delivery modality is monologue (not interactive) and personalized (the learner is addressed in the second person). The agent also makes gestures to direct the learner's attention. Fifth, learner control over the Garbage Bunny is limited as it is always the agent who takes the initiative to provide support, the only control the learner has is to listen again to the agent's explanation. Sixth, support is never differentiated towards different learners. And finally, most support is delivered prior to the task, except for the feedback, which is just-in-time.

Questionnaire.
To identify whether a participant listened and followed the advice of the pedagogical agent, a questionnaire was constructed. This questionnaire consisted of 21 items, i.e. 18 statements (A, B, C, E, F, G, J-U), with which a six point Likert-type scale (totally agree to totally disagree), and three propositions with a two point scale (agree – disagree; D, H and I). Table 2 comprises the 21 propositions, sorted by hypothesis. For listening and obeying, respectively 4 and 5 independent items were used, so no reliability was measured. The other 12 propositions made up one scale to test the perception hypothesis. This scale has a strong internal consistency reliability (Cronbach alpha = .903).

Table 2: *Proposition sorted by hypothesis*

Hypothesis 1	A. I listened to the Garbage Bunny mostly in the beginning of the session.
	B. I listened to the Garbage Bunny during the whole session.
	C. I listened to the Garbage Bunny mostly at the end of the session.
	D. I listened to the summary of the Garbage Bunny at the end of the test
Hypothesis 2	E. I did what the Garbage Bunny told me to do mostly in the beginning of the session.
	F. I did what the Garbage Bunny told me to do during the whole session.
	G. I did what the Garbage Bunny told me to do mostly at the end of the session.
	H. I made use of the underlined words.
	I. I performed a test during the session.
Hypothesis 3	J. The Garbage Bunny has helped me.
	K. The Garbage Bunny has a nice voice.
	L. The Garbage Bunny told stupid things.
	M. The Garbage Bunny looked nice.
	N. The Garbage Bunny has an irritating voice.
	O. The Garbage Bunny made mistakes.
	P. The Garbage Bunny told nice things.
	Q. The Garbage Bunny looked stupid.
	R. The Garbage Bunny distracted me.
	S. The Garbage Bunny frequently told the same things.

	T. The Garbage Bunny did nice things.
	U. The Garbage Bunny was boring.

Pre-test and post-test
In order to test learning results, a pre-test and a post-test were constructed. Both tests consist of 10 multiple choice questions, with five alternatives. The participant always got the possibility to choose the answer "I don't know" and, by explaining the principle of correction-for-guessing, all subjects were urged to choose this answer instead of guessing when they would not know the right answer.
The pre-test assessed participants' prior knowledge. The post-test was a parallel test. In order to avoid problems with regard to different levels of prior knowledge, learning gain was assessed and used as the dependent variable. In a pilot test, both tests were pre-tested in order to ensure reliability and their parallel nature. In the pilot a group of 22 participants of the same age answered all test questions. Mean scores were 4.05 (SD=2.13) on the pre-test and 4.18 (SD= 1.92) on the post-test. The mean difference was .14 (SD= 2.03). The paired t-test showed no significant difference between the two tests ($t(21)=-.315$; $p>.05$ (two-sided)), consequently it was concluded that both tests are sufficiently parallel. The mean scores of both tests also show that they are of a reasonable difficulty. Both pre-test and post-test are internally consistent (pre-test KR20= .97; post-test KR20=.80).

Design and Procedure
Hypotheses were tested by means of a study with a quasi-experimental pre-test post-test design with three conditions. Participants were randomly allocated to one of the conditions.
The pedagogical agent is positively introduced to participants in the POS-group, negatively to participants in the NEG-group and neutrally to participants in the NEU-group. Four dependent variables were measured: learning gain, use of the agent (listening and obeying to the agent) and perception of the agent. Figure 2 provides an overview of the design

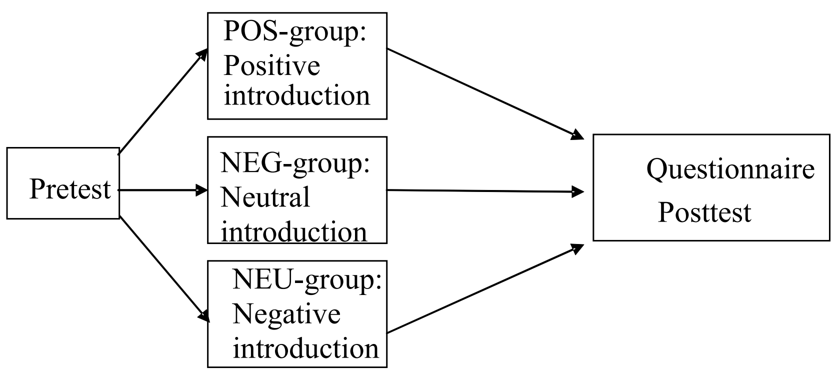

Figure 2: Design

Each participant followed the same procedure. First, participants were asked to fill in the pre-test. Next, the program *Reducing waste for children* was introduced. Depending on the participant's condition, a specific introduction was given. The POS-group was told that the agent is important, that he will help them so that they can achieve higher scores on the post-test, and that one should listen to the agent very carefully. The NEG-group is told the opposite: "although the agent says he'll help you, he's rather stupid and repeats himself a lot, so one should better not listen to him in order to avoid making mistakes on the post-test or to get too much distracted". To the NEU-group the agent is not explicitly introduced.
After the introduction, each participant got half an hour time to work individually with the digital learning environment. Thirty minutes is enough to gain sufficient information to complete the post-test. To give participants a notion of what information to look for to successfully complete the posttest, they were told that the post-test would be about drinking-packages, so in principle they could find all the information needed in one specific location of the virtual school, that is to say the vending machine. Participants were additionally motivated by the promise of a reward after successful completion of the post-test.
After the regular working-time or upon request of the participant, first the post-test was administered and then the questionnaire.

Data analysis

For the dependent variables 'listening', 'obeying', and ‘perception', the mean scores were considered. Since several items were formulated in a negative sense, these scores were first converted.

Item A, B and C, which asked if participants had listened to the agent, and items E, F and G, which asked whether participants had obeyed the agent, were each combined into two additional variables respectively ‘listening’ and ‘compliance’ (respectively. table 3 and 4). Since these variables are categorical in nature, Chi Square tests were performed to test differences between the conditions.

Table 3: *Combination variable ‘Listening’*

“I always listened to the Garbage Bunny”	“I listened to the Garbage Bunny mostly in the beginning of the session”	“I listened to the Garbage Bunny mostly at the end of the session”	Combination Score for ‘listening’
YES	YES	YES	1
YES	YES	NO	2
YES	NO	YES	3
YES	NO	NO	4
NO	NO	NO	5
NO	NO	YES	6
NO	YES	NO	7
NO	YES	YES	8

Table 4: *Combination variable ‘Obeying’*

“I always obeyed to the Garbage Bunny”	“I obeyed to the Garbage Bunny mostly in the beginning of the session”	“I obeyed to the Garbage Bunny mostly at the end of the session”	Combination score for ‘obeying’
YES	YES	YES	1
YES	YES	NO	2
YES	NO	YES	3
YES	NO	NO	4
NO	NO	NO	5
NO	NO	YES	6
NO	YES	NO	7
NO	YES	YES	8

For each of these items, also the single mean score was analyzed, using ANOVA. The Scheffé-test was used for post hoc analyses. For the remaining items (“I made use of the underlined words”, “I performed a test during the session” and “I listened to the summary of the Garbage Bunny at the end of the test”) the Chi Square Test was used. Finally, in order to analyze the participants’ perception of the Garbage Bunny, which is expressed by the mean score of the twelve items regarding the third hypothesis, ANOVA was used.

To measure the effect on learning results learners' learning gains were calculated by subtracting their pre-test score from their post-test score. An ANOVA was performed to study the effect of condition with time-on-task as a co-variable.

Research Results

Impact of the introduction on pupil’s use of a pedagogical agent

Table 5 shows the results of the different analyses for listening to the agent.

Table 5: *Results for 'listening'*

LISTENING				
		Condition		
		Positive intro (n=26)	No intro (n=30)	Negative intro(n=25)
Combination	1	23.1%	16.7%	0%
	2	26.9%	13.3%	4%
	3	0%	0%	0%
	4	7.7%	16.7%	4%
	5	11.5%	16.7%	56%
	6	0%	3.3%	4%
	7	23.1%	30%	28%
	8	7.7%	3.3%	4%
Always listen	Mean	3.73 (SD=1.041)	3.40 (SD=1.632)	1.68 (SD=1.069)
Mostly in the beginning	Mean	4.69 (SD=1.320)	4.00 (SD=1.438)	2.84 (SD=1.434)
Mostly at the end	Mean	3.04 (SD=1.341)	2.47 (SD=1.479)	1.80 (SD=1.190)
Listening to summary at the end of the test	#Yes	19	17	12
	#No	5	10	12

The results for 'listening' show differences between the three conditions. Chi squared analyses show a significant association listening and condition (χ^2 (12)=25.357; p≤0.05 (two-sided)). Because more cells have an expected value of less than 5, Fisher Exact Test was executed. This confirmed the findings of the Chi squared analyses (Fisher Exact Test= 24.431, p≤0.05 (two-sided)).

Descriptives indicate that the three largest differences between the conditions are for scores 1, 2 and 5. Almost a quarter of participants in the positive introduction condition says to have listened the whole time, in the beginning as well as at the end (score 1), compared to none of the participants in the negative introduction condition. While for listening the whole time (score 4), a difference can also be observed between the positive and the neutral introduction conditions, this difference is much smaller.

The results for score 2 (listening all the time but more at the beginning) are analogous. Compared to the neutral group, less participants in the negative group condition claim to have listened to the agent all the time, but more in the beginning than at the end. In contrast, more participants in the positive introduction condition group than participants in the neutral condition state to have listened to the agent all the time, but more in the beginning than at the end.

For score 5 it can be seen that participants who got a negative introduction, state far more than members of the other two groups never to have listened to the Garbage Bunny. The difference between the positive introduction condition and the neutral group is smaller than the difference between the positive introduction condition and the negative introduction condition.

All these results are in line with the first hypothesis.

For the other scores, the differences between the three conditions are much smaller. While score 7 (only listening at the beginning) appears relatively often in all three conditions, no participant says to have listened the whole time but more at the end than in the beginning (score 3). The number of participants falling in the other categories (4, 6 and 8) is rather small in each condition.

The three items pertaining to listening were also analyzed separately. The ANOVA shows that the effect of condition on the three propositions is significant (F(2,80)=18.410; p≤0.05; η^2=0.321 for the first proposition; F(2,80)=11.378; p≤0.05; η^2=0.226 for the second; F(2,80)=5.359; p≤0.05; η^2=0.121 for the third one). This means that condition accounts for 32% in the variance in "always listening", for 22.6% in "listening mostly in the beginning" and for 12.1% in "listening mostly at the end". In other words, the effect of the introduction is strong in the first two cases and moderate in the latter case (Cohen, 1988).

Post hoc tests give more information: for the propositions "always listening" and "listening mostly in the beginning", only the negative introduction group significantly differs from the other two groups, while the positive and the neutral introduction group do not significantly differ. For the proposition "listening mostly at the end", only the difference between the positive and the negative group is significant.

Finally, also a concrete moment of listening to the agent was asked about, by means of the proposition "I have listened to the agent's summary at the end of the test". No significant association with condition was found: $\chi^2(2)= 4.450$; $p>0.05$ (two-sided).

Table 6 presents the results are presented relating to the compliance with the agent.

Table 6: *Results for obedience*

OBEYING				
		Condition		
		Positive intro (n=26)	No intro (n=30)	Negative intro(n=25)
Combination	1	30.8%	16.7%	0%
	2	15.4%	13.3%	8%
	3	3.8%	3.3%	0%
	4	15.4%	20.0%	0%
	5	3.8%	20.0%	76%
	6	7.7%	3.3%	8%
	7	19.2%	20.0%	8%
	8	3.8%	3.3%	0%
Always listen	Mean	3.73 (SD=1.343)	3.60 (SD=1.653)	1.96 (SD=1.274)
Mostly in the beginning	Mean	4.08 (SD=1.412)	3.53 (SD=1.676)	2.24 (SD=1.268)
Mostly at the end	Mean	3.42 (SD=1.238	2.53 (SD=1.655)	1.80 (SD=1.155)
Clicking on hyperlinks	#Yes	15	23	15
	#No	11	7	10
Executing a test	#Yes	24	27	24
	#No	2	3	1

For the effect of the introduction on the obedience to the agent (hypothesis 2), the analysis also started with the combination variable 'compliance'. The Chi squared test shows a significant association between the conditions and compliance ($\chi^2(14)= 39.584$; $p\leq0.05$ (two-sided)). Because several expected values are less than 5, the Fisher Exact Test was executed, which confirmed the findings of the Chi squared test (Fisher Exact Test= 40.136, $p\leq0.05$ (two-sided)). Largest differences are those for score 1 (always obeying both at the beginning and at the end) and score 5 (never obeyed). A comparison of the three conditions reveals that the positive introduction group is more represented for score 1 (always obeying, in the beginning as well as at the end). On the contrary, the negative group is far more represented for score 5, which in contrast to score 1 represents the absence of compliance (never obeying, neither in the beginning, nor at the end). The neutral group falls in between the two other groups. All these findings are in line with expectations and confirm the second hypothesis.

Also here, separate analyses were done on the individual items. Results of the ANOVA analyses are analogous to those for the first hypothesis. For each of the three items, analyses reveal a main effect of condition (($F(2,80)= 11.998$; $p\leq0.05$; $\eta^2=.235$ for the first item; $F(2,80)= 10.426$; $p\leq0.05$; $\eta^2=.211$ for the second item; $F(2,80)= 8.784$; $p\leq0.05$; $\eta^2=.184$ for the third item). The condition explains 23.5% of the variance in "always obeying to the agent", 21.1% of the variance in "obeying mostly in the beginning" and 18.4% of the variance in "mostly obeying at the end". In other words, the condition has a large effect on always, mostly in the beginning and mostly at the end obeying to the agent. But once again, post hoc tests show that these connections are only significant between the negative introduction condition and the other two conditions in case of the first two items and only between the negative and the positive introduction condition in case of the third item.

The two remaining items asked about two concrete moments of obedience to the agent: "I have clicked on the hyperlinks" and "I have executed a test in the program". Chi squared analyses showed no significant differences between the three conditions, for neither of the items (respectively: $X^2(2)= 2.689$; $p>0.05$ (two-sided) and $X^2(2)= .720$; $p>0.05$ (two-sided)).

Impact of the introduction on participants' perception of the agent.

Table 7 summarizes the results for the variable 'perception'.
The descriptive statistics of general perception (i.e. the mean score for all of the twelve items which asked about perception) suggest that the three conditions differ from each other as predicted by the third hypothesis: the positive group ($\overline{X}$ =4.33, SD=.96) > neutral group ($\overline{X}$ =4.29, SD=1.06) > negative group ($\overline{X}$ =3.19, SD=.88). ANOVA confirms a main effect of condition on general perception ($F(2,80)= 11.366$; $p\leq0.05$; $\eta^2=.226$). More precisely, the nature of the introduction is responsible for 22.6% of the variance in perception. Post hoc analyses however show that the difference is only significant between the negative introduction condition and the other two conditions. Thus, hypothesis 3, which states that the way the agent is introduced (positively, neutrally or negatively) has an impact on perception, is only partly confirmed.

Table 7: *Results for perception of the agent*

PERCEPTION				
		Condition		
		Positive intro (n=26)	No intro (n=30)	Negative intro (n=25)
General perception	Mean	4.33 (SD=0.96)	4.29 (SD=1.06)	3.19 (SD=0.88)

Impact of introduction on learning gains.

Table 8 shows the results for learning gains.
First it was examined if the time the learner worked with the program or the school to which the subject belonged had any significant effect on the learning results (e.g. Carroll, 1963). This analysis showed that time-on-task had a significant effect on the learning results, ($F(1,80)= 6.712$; $p\leq0.05$; $\eta^2=.082$), the school however did not ($F(4,80)= 1.181$; $p>0.05$; $\eta^2=.059$). So it was decided to consider time-on-task as a co-variable in further analyses.

Table 8: *Results for learning gains*

LEARNING GAIN				
		Conditie		
		Positive intro (n=26)	No intro (n=30)	Negative intro (n=25)
Learning progression	Mean	1.28 (SD=2.15)	2.27 (SD=2.45)	2.35 (SD=3.23)

The ANCOVA-analyses show no significant connection between condition and learning gain ($F(2,80)= ,949$; $p>0.05$; $\eta^2=.025$). The co-variable 'time-on-task' has a significant effect on the learning gain ($F(1,80)= 7,553$; $p\leq0.05$; $\eta^2=.091$), but because there is no significant effect of condition on time-on-task ($F(2,80)= ,942$; $p>0.05$; $\eta^2=.024$), it seems there is no indirect effect of the condition on the learning results by way of the working time either.

Discussion and conclusion

This study addresses one main research question: Can features of the total learning environment affect the impact of (components of) a digital learning environment? From a socio-constructivist point of view, it is important to consider these possible contextual influences. Moreover, this makes this research more ecologically valid as in regular settings a digital learning environment is nearly always part of a larger environment. This study focused on the impact of one such contextual element, namely the teacher, and on one element of a digital learning environment, a so-called pedagogical agent: what effect does the teacher's introduction have on the use (listening and obedience) and perception of the agent by learners and on their learning results?
While not entirely, results seem to confirm the first two expected effects (use and perception). In case of a negative introduction, it was found that pupils tend to listen to and obey the agent less and perceive him less positively, than in case of a positive or neutral introduction. However, no effect was found of a positive introduction. This finding is clearly in line with research on the so-called negativity effect (De Bruin & Van Lange, 1999; Fiske, 1980; Hamilton & Zanna, 1972; Peeters & Czapinski, 1990; Reeder & Coovert, 1986; Richey et al., 1967). At the same time it raises questions about the limits of the media equation hypothesis or at least induces a plea to more systematically consider the context when discussing the impact and effect of digital

learning environments. Finally, no effect of the introduction was found on the learning results. Because an existing, completed program was used, it was however impossible to turn off the agent. So a first limitation of the present study is the fact that there was no ‘no-agent’- condition. As a consequence, we do not know if the Garbage Bunny as such has a significant impact on learning results.

The findings of the present study have several implications, both for future research and for the use of pedagogical agents in schools.
First, this study has demonstrated that things told about the pedagogical agent by the teacher, and particularly negative information, has an impact on how much students listen to and obey the agent, and how they perceive him. This study gives a first indication that the total learning environment can affect the digital component of the learning environment and that interactions between different components of the total environments and its subcomponents may greatly affect their effectiveness and functionality. With respect to research on pedagogical agents, this means that more attention should be given to influences of the external environment and to the concrete contexts of use.
Concerning the use of agents in classrooms, these results draw attention to the fact that teachers should be careful about the way they talk about digital material, e.g. pedagogical agents. For example, a teacher who does not like pedagogical agents can affect the way the agent is perceived, by showing his/her opinion to his/her pupils. This study however did not confirm that this would have a negative effect on learning results.

Another limitation of this study relates to the interpretation that parts of the results might be due to a social desirability bias (Furnham, 1986; Kalton & Schuman, 1982, Nancarrow & Brace, 2000). The subjects were aware of the researcher’s (fake) opinion about the agent and because they were only directly asked about their use and perception, it might be possible that they have answered according to what they thought the investigator would like to hear. This problem can be solved in future research by using unobtrusive measures, like e.g. log files which can register every mouse click and by using different researchers to introduce the agent and administer the instruments.

Finally, the plausibility of the theoretical explanation of the fact that only a negative introduction has an impact, namely the ‘negativity bias’, remains to be further examined.

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Patterns in Education: Linking Theory to Practice

Theodore W. Frick
Jaesoon An
Joyce Koh

Abstract

Analysis of patterns in time and configuration (APT&C) is a measurement and analysis paradigm that bridges qualitative and quantitative research methods. APT allows analysis of temporal events (both joint and sequential occurrences), whereas APC permits investigation of structural relations or configurations. Temporal patterns can be quantified in APT, resulting in probability estimates of their occurrence. Structural relations in APC are characterized by properties that are measured quantitatively, such as: passive dependence, independence, hierarchical order, complexity, strongness, vulnerability, and wholeness. APT&C is based on theories from mathematics and general systems theory.

Three empirical studies which have used APT&C are described in this article: 1) academic learning time of mildly handicapped students in elementary school learning environments; 2) patterns of mode errors in human-computer interaction with graphical interfaces in modern software; and 3) structural configurations for supporting student autonomy in a Montessori classroom.

The value of APT&C is that results can be directly related to practice. Through APT&C we have new ways of conducting educational research in order to shed light on practices that result in the outcomes we seek.

The Dilemma: Qualitative vs. Quantitative Methodologies

Research methods in education used for much of the 20th century were largely quantitative methods. Experimental and quasi-experimental designs were commonplace (e.g., Campbell & Stanley, 1966), and analytical techniques included ANOVA, regression analysis and their extensions (i.e., discriminate, factor, canonical and path analysis). The basic problem is that this general linear models approach seldom yielded findings that could be directly linked to educational practice. Within-group and within-person variance was often large, typically obfuscating differences between groups that could be attributed to so-called treatments, practices or programs (Medley, 1977; 1979). Cronbach & Snow (1977) further extended ANOVA to deal with aptitude-treatment interactions (ATI), with hopes of reducing the within-group variance. But this, too, was seldom successful in yielding significant results.

In the 1970s and 80s, others began to explore alternative approaches that later became known as qualitative and case study methodology (cf. Guba & Lincoln, 1985; Stake, 1995; Yin, 2003). Qualitative methods have become widely used in educational research in the past two decades. One clear advantage of qualitative methods is that rich details of individual cases can give readers helpful insight into and understanding of the educational phenomena investigated. The unavoidable dilemma that often accompanies this approach is lack of justification for generalizability of findings. When samples are purposive and small, generalizability in the sense of making inferences from sample to population is seriously compromised. Indeed, respected books on qualitative methods avoid the term 'generalizability' and instead employ the notion of 'transfer' – i.e., results of what was found in this particular investigation *may* transfer to other similar situations the reader encounters (cf. Merriam, 1997).

Mixed methods approaches have become more popular in recent years (Creswell, 2003), in which both strengths of qualitative and quantitative approaches have been utilized. Well before this, an approach that quantified qualitative patterns had been proposed: APT.

Measuring System Dynamics: APT

Frick (1990) proposed an analytic-measurement procedure called Analysis of Patterns in Time (APT). This is a *fundamental change in perspective* for quantitative methodologists steeped in the linear models tradition and the measurement theory it depends on (cf. Kuhn, 1962). The primary difference is that the *linear models approach relates independent measures through a mathematical function and treats deviation as error variance. On the other hand, APT measures a relation directly by counting occurrences of when a temporal pattern is true or false in observational data*. Linear models relate the measures; APT measures the relation.

Academic Learning Time Study

Frick (1990) conducted a study of 25 systems in central and southern Indiana in which mildly handicapped children were observed throughout the day in their elementary school classroom learning environments. Each child was observed between 8 and 10 hours across multiple days over a semester. These environments ranged from self-contained classrooms for special education students to regular classrooms in which the mildly handicapped children were mainstreamed (now called inclusion). Trained classroom observers coded the kinds of academic learning activities provided, and within each academic activity the behaviors of target students and instruction made available to the student were coded at one-minute intervals. During data analysis, student behaviors at each time sampling point were collapsed into two categories: engagement and non-engagement. Similarly, instructional behaviors at each sampling point were collapsed into two categories: direct instruction and non-direct instruction.

Linear models approach. As can be seen in Figure 1, if the data are analyzed with the linear models approach, student engagement can be predicted by a regression equation. Approximately 33 percent of the variance in student engagement can be accounted for by the amount of direct instruction provided. While this finding shows that there is a statistically significant positive relationship ($p < 0.05$) that is moderate in size, there is still a great deal of uncertainty (67 percent of the variance is unaccounted for). Notice that the vertical lines (blue) indicate the distances from the data points and the regression line (red), indicating *errors* in prediction. The relationship between direct instruction and engagement is represented by a function for a line. In this example, the function for the line is: EN = 0.57 + 0.40DI. Each data point represents the overall proportion of engagement for a particular student, paired with the overall proportion of direct instruction provided to that student. Engagement is aggregated *separately* from direct instruction for each case, so there is one overall engagement score for a student and one overall direct instruction score. Thus, there are 25 data pairs from which the regression equation is estimated.

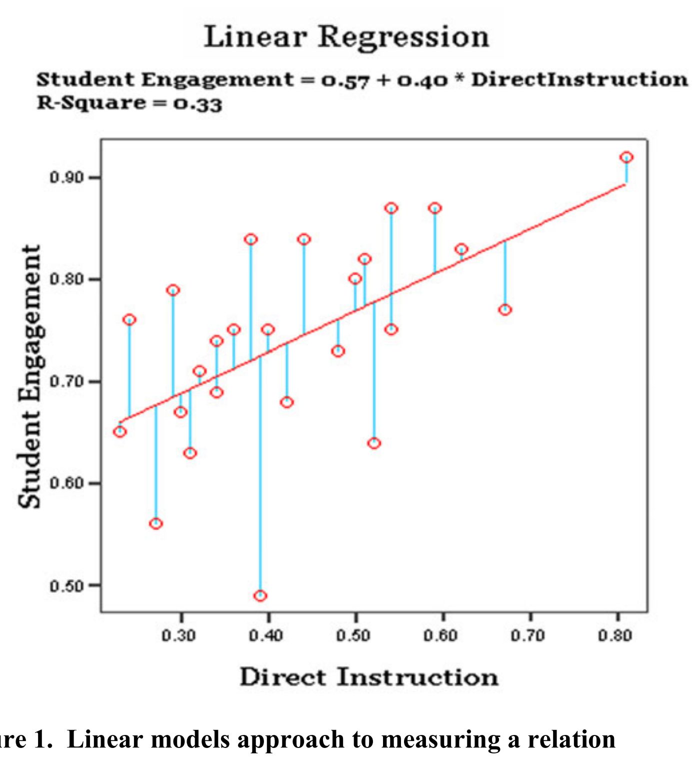


Figure 1. Linear models approach to measuring a relation

APT analysis. The same data were analyzed from an APT perspective. From this perspective data are aggregated differently. The *joint occurrences* of student engagement and instruction were counted in order to form probabilities or proportions. For example, for student 1, the *probability* of (DI & EN) = 0.46; p(DI & NE) = 0.04; p(EN | DI) = 0.92; and p(EN | ND) = 0.67. These joint and conditional probability estimates for this student were based on nearly 500 data points where the joint occurrences of instruction and engagement were observed and coded. Similar

probabilities were estimated for the remaining 24 systems, and then the probabilities were averaged. Thus, there were nearly 15,000 data points representing the joint occurrences of direct instruction and engagement in the 25 systems. See Table 1.

Table 1. Temporal Relationships: Joint Occurrences of Direct Instruction (DI), Student Engagement (EN), Non-direct Instruction (ND), and Student Non-engagement (NE) in Columns 3 - 6; Conditional Occurrences in Columns 7 - 8.

p(DI)	*p*(EN)	*p*(DI & EN)	*p*(DI & NE)	*p*(ND & EN)	*p*(ND & NE)	*p*(EN|DI)	*p*(EN|ND)
0.50	0.80	0.46	0.04	0.34	0.16	0.92	0.67
0.39	0.49	0.37	0.02	0.12	0.49	0.95	0.20
0.27	0.56	0.26	0.01	0.30	0.43	0.97	0.41
0.34	0.69	0.34	0.00	0.35	0.31	1.00	0.53
0.48	0.73	0.47	0.01	0.25	0.26	0.98	0.49
0.40	0.75	0.39	0.01	0.35	0.25	0.98	0.59
0.44	0.84	0.40	0.04	0.44	0.11	0.91	0.80
0.36	0.75	0.33	0.03	0.42	0.22	0.92	0.65
0.30	0.67	0.29	0.01	0.39	0.32	0.96	0.55
0.32	0.71	0.31	0.01	0.40	0.29	0.98	0.56
0.42	0.68	0.42	0.00	0.26	0.31	0.99	0.46
0.38	0.84	0.37	0.01	0.47	0.15	0.97	0.75
0.31	0.63	0.31	0.00	0.32	0.37	1.00	0.46
0.54	0.87	0.52	0.02	0.36	0.11	0.97	0.77
0.81	0.92	0.81	0.00	0.11	0.08	1.00	0.57
0.67	0.77	0.62	0.05	0.15	0.18	0.93	0.45
0.24	0.76	0.24	0.00	0.52	0.24	1.00	0.69
0.34	0.74	0.34	0.00	0.40	0.25	0.99	0.61
0.59	0.87	0.58	0.01	0.29	0.12	0.99	0.71
0.52	0.64	0.48	0.04	0.16	0.33	0.93	0.33
0.62	0.83	0.58	0.04	0.25	0.13	0.94	0.66
0.23	0.65	0.22	0.01	0.43	0.34	0.97	0.56
0.29	0.79	0.28	0.01	0.51	0.20	0.97	0.71
0.54	0.75	0.52	0.02	0.23	0.24	0.97	0.49
0.51	0.82	0.50	0.00	0.31	0.18	0.99	0.63
Mean *(SD)*	***Mean*** *(SD)*	***Mean*** *(SD)*	***Mean*** *(SD)*	***Mean*** *(SD)*	***Mean*** *(SD)*	***Mean*** *(SD)*	***Mean*** *(SD)*
0.432 (0.144)	**0.741** (0.101)	**0.416** (0.139)	**0.015** (0.010)	**0.324** (0.114)	**0.243** (0.104)	**0.967** (0.029)	**0.573** (0.142)

When direct instruction was occurring, these students were engaged on average about 0.967 (SD = 0.029). In the absence of direct instruction, their average engagement was about 0.573 (SD = 0.142). In other words, such students were 13 times more likely to be off-task during non-direct instruction [(1 – 0.573)/(1 – 0.967) = 0.427/0.033 = 12.94]. APT measures the temporal relation between direct instruction and student engagement. The error in prediction is indicated by the standard deviation of the mean percent of time. For the *p*(EN|DI) mean (0.967), the standard deviation was quite small (0.029). In a normal distribution, 95 percent of the scores will fall between 1.96 standard deviations above the mean and 1.96 standard deviations below. For the *p*(EN|ND) mean (0.573), the standard deviation was much larger (0.142), indicating much more variation in student engagement when non-direct instruction was occurring. In other words, student engagement was not only lower but it was less predictable when non-direct instruction occurred, compared with occurrences of direct instruction.

When analyzing the same observational data in APT framework, the conclusions are very clear. For these mildly handicapped students, if direct instruction was occurring, then they were very likely to be on-task, and this was

very consistent across all students, regardless of the specific learning environment in which they were observed. During non-direct instruction, students were much more likely to be off-task, though this was less predictable. These results have direct implications for practice. More details are provided in Frick (1990).

It should be noted that observational data were collected temporally. In this case, joint occurrences of student and instructor behaviors were coded at one-minute intervals (time sampling). Alternatively, *sequences* of behavior or events can be observed and coded, as illustrated in the next study, reported below. If observations are not made in these ways, it is not possible to conduct APT. As can be seen in Table 1, when independent measures are obtained as would normally be the case under traditional views of measurement, one would *only* have the data in the first two columns for analysis. This is how measurement has been traditionally conceived: measure things separately, then relate the measures by means of some kind of function. A measure of association is used to indicate the relationship, such as a Pearson Product Moment Coefficient. Columns 2-8 in Table 1 were created because an APT perspective was taken in the design of how the *relation was coded by observers* (between student engagement and instruction). One would *not* have the remaining columns of data for analysis had these variables been measured independently. Only because an APT perspective was taken was it possible to estimate the conditional probability of the relation, p(EN|DI), for each target system. Moreover, APT measures of relation can be aggregated and subjected to standard methods of analysis, such as computation of means and standard deviations, as well as linear regression, illustrated in the academic learning time study by Frick (1990).

Patterns of Mode Errors in Human-Computer Interfaces

This empirical study by An (2003) illustrates the value of the merging of qualitative methods and quantification via APT. She investigated conditions of mode errors when people use modern software. Mode errors occur when the same user action results in more than one outcome, depending on the context. Mode errors can cause serious problems for software users, such as inadvertent destruction of important work, decreased productivity, and task incompletion.

Sixteen college students were each asked to perform eight computer tasks during usability tests of three modern direct-manipulation software interfaces. Stimulated recall interviews were conducted immediately afterwards as subjects watched themselves on videotape to clarify why they took certain actions during the tests. An observation system was devised for coding tapes of usability tests to record behavioral patterns of the participants.

Qualitative analysis of the results indicated three major types of mode errors: A) right action, wrong result; B) it isn't there where I need it; and C) it isn't there at all. A source of error analysis revealed that mode errors appear to result from eight categories of design incongruity: unaffordance, invisibility, misled expectation, unmet expectation, mismatched expectation, inconsistency, unmemorability, and over-automation. Consequences of mode errors included: can't find hidden function, can't find unavailable function, false success, stuck performance, inhibited performance, and inefficient performance.

Analysis of patterns in time (APT) was used as a quantitative method to determine the likelihoods of temporal patterns of types, sources and consequences of mode errors. Results of queries regarding temporal patterns were as follows:

Table 2. Sequential patterns of mode errors, their sources, and consequences.

		Query	***Relative Frequency***	***Likelihood (p)***
Type A	**1**	**IF type of mode error IS *right action, wrong result*,**	**34 out of 52**	**0.65**
	a)	AND IF source of mode error IS *unaffordance*,	15 out of 34	0.44
		THEN consequence IS *can't find hidden function* OR *false success*?	10 out of 15	0.67
	b)	AND IF source of mode error IS *invisibility*,	6 out of 34	0.18
		THEN consequence IS *stuck performance*?	5 out of 6	0.83
	c)	AND IF source of mode error IS *misled expectation*,	7 out of 34	0.21
		THEN consequence IS *false success*?	6 out of 7	0.86

Type B	**2**	**IF type of mode error IS *it isn't there where I need it*,**	**8 out of 52**	**0.15**
	a)	AND IF source of mode error IS *mismatched expectation*,	8 out of 8	1.00
		THEN consequence IS *can't find hidden function*?	8 out of 8	1.00
Type C	**3**	**IF type of mode error IS *it isn't there at all*,**	**10 out of 52**	**0.19**
	a)	AND IF source of mode error IS *unmet expectation*,	10 out of 10	1.00
		THEN consequence IS *can't find unavailable function*?	10 out of 10	1.00
	b)	AND IF source of mode error IS *unaffordance*,	3 out of 10	0.30
		THEN IF source of mode error IS *unmet expectation*,	3 out of 3	1.00
		THEN consequence IS *can't find unavailable function*?	3 out of 3	1.00

Query 1a consists of three phrases. Phrase 1 (IF type of mode error IS it *isn't there where I need it*) occurred for 34 out of the 52 mode errors observed (p = 0.65). Given that Phrase 1 was true, Phrase 2 (AND IF source of mode error IS *unaffordance*) was observed to be true for 15 out of those 34 occasions [p(Phrase 2 | Phrase 1) = 0.44)]. Given that both Phrases 1 and 2 were true, Phrase 3 (THEN consequence IS *can't find hidden function* OR *false success*?) was observed to be true for 10 out of those 15 occasions [p(Phrase 3 | Phrase 2 | Phrase 1) = 0.67)]. This is interpreted to mean that when users did the right action but got the wrong result, the source of user error was often software interface elements that lacked affordance (functionality that is not obvious). This frequently resulted in users being unable to find a software function that was hidden from view, or they thought they did the task correctly only to find out later they had not (false success). When these conditions for modes occurred, software users in this study were unsuccessful *67 percent of time* in tasks they were trying to do.

While a larger random sample of a broader range of users beyond college undergraduates would be needed to increase generalizability, these findings nonetheless illustrate measurement and analysis of sequential patterns of mode errors and their estimated likelihoods. These findings offer useful guidance to software designers who want to make their products easier to use by minimizing sequences of human errors such as those observed in this empirical study.

While this particular study does not examine patterns of teaching and learning that would be of more direct interest to educators, it does illustrate the value of a difference in approach to measurement. This study demonstrated the practical value of mixed methodologies where one first uses qualitative methods for gaining understanding of patterns and relationships, and then uses APT to code and quantify those temporal relationships in a manner that is useful to practitioners for making decisions based on APT predictions.

Further information on formal definitions of APT sequences and associated pattern counting rules can be found in Frick (1983), Chapters 2 and 5 (note that APT was originally called nonmetric temporal path analysis but the name was changed to prevent confusion with conventional path analysis; only the name has changed).

Measuring System Structure: APT&C

Thompson (2006) provided the significant insight that APT could be extended to characterize *structure* or configuration of educational systems, in addition to characterizing system *dynamics* – or processes in education – as APT was designed originally to do. Frick and Thompson have since extended APT to measure and analyze configurations in education (APT&C, 2005).

Configural patterns characterize *structures* in education – i.e., how education is organized, or relations between parts. Axiomatic Theories of Intentional Systems (ATIS) provides the theoretical foundation for *quantitative* measures of system structure required by APT&C (Thompson, 2006). These measures include: complexity, hierarchical order, heterarchical relatedness, compactness, centrality, flexibility, active dependence, passive dependence, independence, interdependence, strongness, unilateralness, weakness, wholeness, and vulnerability.

ATIS is a systems theory that predicts relationships among system properties, both structural and dynamic. There are over 200 axioms and theorems in ATIS. For example, #106 predicts: *If system strongness increases, then toput increases*. See Thompson (2006) and ATP&C (2005) for further details.

Koh (2005) was engaged in research on student autonomy. She realized that ATIS properties and APT&C would help the analysis of ethnographic classroom observational data she planned to collect. Measuring structural properties of systems is a way to characterize classroom structure that supports student autonomy.

Student Autonomy Structures in a Montessori Classroom

Autonomy or self-determination was defined by Deci, Vallerand, Pelletier & Ryan (1991) as a state where volition for action is totally internalized and determined by intrinsic motivation and not by external conditions. According to self-determination theory, intrinsic motivation cannot be fostered if autonomy support was lacking in social environments. Experimental studies and self-reported surveys conducted with school-age children found that perceived autonomy had a positive impact on perceived competence, intrinsic motivation and conceptual learning of school-age children (Grolnick & Ryan, 1987; Valas & Sovik, 1993; Hardre & Reeve, 2003).

The Montessori system aims to educate each child towards self-mastery and independence (Montessori, 1964). A distinguishing feature of Montessori classrooms is its provision for student autonomy. In a study comparing the social context of Montessori and traditional middle schools, Rathunde & Csikszentmihalyi (2005) found that Montessori students reported more support from teachers, more order in the classroom and spent more time with academic work rather than in passive listening.

Koh's (2005) case study explored how classroom structures support student autonomy in a Montessori classroom. Ten one-hour observations were conducted in April, 2006, in an upper elementary Montessori classroom located in southern Indiana. It had twenty-eight students, ages 10-12, a Montessori-certified head teacher and two assistant teachers.

Data on interactions between teachers, students and classroom resources were collected through ethnographic field-notes. The constant comparative method (Creswell, 1998) was used to identify common interaction patterns and classroom activity structures.

Measures of structural configurations were determined using definitions from ATIS. For example, one definition is:

$\mathcal{M}$: **Active dependent-component partition measure,** $\mathcal{M}(_{AD}\mathbb{S})$, $=_{df}$ **a measure of initiating affect-relations.**

$$\mathcal{M}(_{AD}\mathbb{S}) =_{df} [(\Sigma_{i=1,\ldots,n}[\Pi d_I(v) \div \log_2|\mathcal{A}_i|]) \div n] \times 100$$

An investigator constructs a directed graph representing the affect relations in the system, consisting of vertices (*v*) and edges (*e*). The degree (*d*) of a vertex is the number of edges that touch it, and the degree of initiating edges is the number whose direction is leading *from* a vertex, ($d_I(v)$). $|A_i|$ is the cardinality of the set of components in the affect relation, where *i* indexes the different types of affect relations in the system. See reports for further technical details on structure measures and ATIS (APT&C, 2005).

Koh (2005) was interested in the structure of affect relations concerning 'choice of work' and 'guidance of learning'.

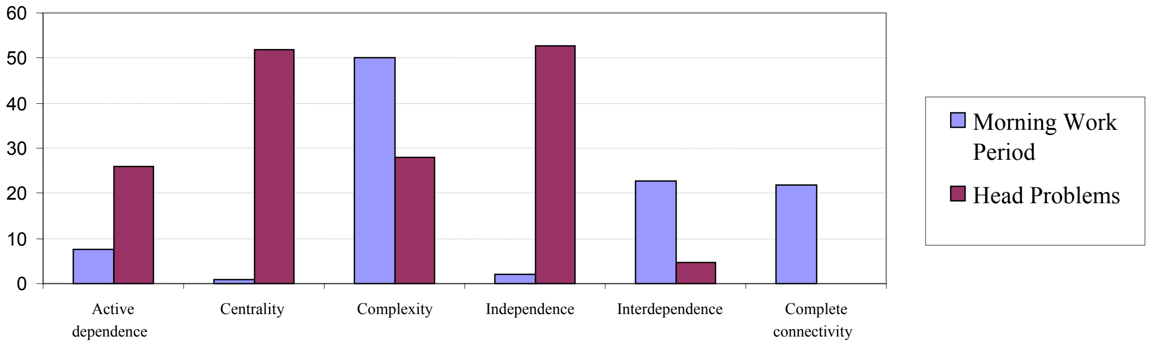
Apparent from classroom observations and confirmed through teacher interviews, there were two clearly different activity structures in the mornings. Students normally started each day with a new *Head Problems* worksheet created by the teacher, consisting of math and logic-related problems. When this was completed (usually within an hour), they typically spent the next three hours in the *Morning Work Period*, during which students chose the type of *works* they wanted to engage in. *Works* constituted the major part of their learning goals: research projects related to physical science, natural science, history and geography; and book reports, science experiments and math workbooks that students needed to complete each nine-week period.

The *Morning Work Period* supported student autonomy with respect to which *works* they wanted to do, and whether they wanted to work on them individually or collaboratively. This morning activity pattern of initial *Head Problems* followed by the long *Morning Work Period* was consistent in all ten observations.

The data depicted in Figure 2 are from a typical configuration selected from one morning, since this configuration was relatively stable from one day to the next. While the specific *works* chosen by students tended to differ each time (as well as the daily worksheets for *Head Problems*), the activity structures with respect to the 'choice' and 'guidance' affect relations were highly similar (homeomorphic).

‘Centrality’ measures the number of indirect connections from each primary initiating component (i.e., one with a directed edge *from* that component which does not have a directed edge *to* it) to all others.
During *Head Problems*, ‘centrality’ was found to be substantially higher since the teacher chose the same activity

Property Value



Structural Property

Figure 2. Measures of structure of affect relations for ‘choice’ and ‘guidance of learning’

for all students to work on. In comparison, during the *Morning Work Period* the students chose various specific works they wanted to engage in (from literally hundreds of resources available) and who they wanted to work with. Correspondingly, ‘complexity’ (the number of connections between teachers, students and resources (*works*) in the classroom) was also higher during this time, since nearly every student was typically engaged with a different specific *work* (i.e., individualized instruction via engagement in that *work*).

‘Active dependence’ measures the number of emanating paths where connections were initiated, while ‘complete connectivity’ measures the structure where connections were both initiated and received. During *Head Problems*, ‘active dependence’ was higher since the teacher chose the head problems for all the students to work on. Without corresponding choice from students, ‘complete connectivity’ was non-existent. During the *Morning Work Period*, ‘complete connectivity’ characterized the structure regarding each student who selected the particular work which in turn guided their learning.

‘Interdependence’ was higher during the *Morning Work Period* as there were more instances of children choosing to work collaboratively with peers. Consequently, ‘independence’ was lower, as there were few instances of primary initiating components with respect to choice *and* guidance. Observations and interviews with teachers also indicated that free-flowing nature of the *Morning Work Period* enabled them to have one-to-one feedback sessions with students on report drafts written about their individual *works*. These sessions could be as long as 45 minutes per student and gave teachers the opportunity to personalize instruction and correct errors.

The three teachers’ responses to the *Problems in Schools Questionnaire* (SDT Website, 2006a) showed all three of them to be ‘Highly Autonomy Supportive’. They valued encouragement, empathy and student viewpoints over the use of extrinsic rewards and punishment. This was evidenced by them encouraging students to be critical about the *Head Problems*. When there was missing or wrong information that might hinder problem solution, students were encouraged to provide suggestions and help contribute to the problem solution by researching for the required information.

Nevertheless, support for autonomy did not preclude the need for classroom management. Teachers were observed to be unhesitant to manage students when there were disciplinary problems or who were off-task during both the *Morning Word Periods* and *Head Problems*. This corresponded with Montessori’s philosophy that while student choice is respected, students who disrupt learning are stopped and redirected.

The structural configurations and teaching strategies were found to have a positive impact on the extent to which students felt intrinsically motivated to learn. Student responses to the Academic Self-Regulation Questionnaire (SDT Website, 2006b) indicated that they had a greater tendency to undertake learning activities

because they perceived some personal value and identification with the learning goals, rather than because they felt compelled by external factors.

It should be noted that Koh (2005) was able to construct digraphs of relations between components in the classroom, i.e., between specific students, their works, and their teachers. Those digraphs do *not* depict temporal interactions. Rather they indicate a set of structural relationships, such as student Mary *chose* a research activity in cultural geography in a subtropical climate (this is an affect relation concerning student choice of work). And, in turn, Mary's learning was guided by the instructional materials on biomes and card materials on animals and foods in that biome (this affect relation concerns the guidance of learning). In a similar manner, the remainder of the digraph was constructed for other students and works chosen, including a few students who were receiving individual guidance from their teachers.

While the specific works chosen would change from day to day, and even within the morning work period, the structural pattern of relationships was relatively constant. Mathematically speaking, the structures were homeomorphic. The constructed affect relation matrix was then entered into a software prototype for doing APC property measure calculations, and those quantitative results were reported in Figure 1. Further information on structural measures such as centrality and independence can be found in report 11, ATIS Graph Theory, by Kenneth Thompson (2006) at: http://education.indiana.edu/~aptfrick/reports/11ATISgraphtheory.pdf .

Can I Do APT&C with my Existing Data?

Ordinarily, the answer to this question is no. One must observe and record the temporal patterns before they can be counted. Configurations must also be observed and recorded in order to measure structural properties. Digraphs or corresponding matrices can be constructed that indicate the structure of the observed system.

While it is entirely possible to do APT&C by hand with the aid of a pocket calculator, it can become extremely tedious to do the counting, as well as error prone. Computer software to assist in both data collection and analysis is under development at Indiana University. For further information, see the APT&C Website at: http://www.indiana.edu/~aptfrick.

Summary

Through APT&C we have new ways of conducting educational research in order to shed light on practices that result in the outcomes we seek. APT is a way to measure and analyze temporal patterns, including system dynamics and processes. APC is a way to measure and analyze configurations of structural relations in education. APT&C is a paradigm shift in how we observe and measure phenomena in education and other settings. APT&C contains both qualitative and quantitative aspects, yet it is neither quantitative research methodology as traditionally conceived, nor is it qualitative methodology. APT&C is grounded in mathematical theories (set theory, probability theory, graph theory, topological theory) and general systems theory.

In this paper, three different research studies were summarized. One focused on mildly handicapped student and instructor behavior in elementary school settings; another looked at adults trying to use modern computer interfaces and their struggles due to mode errors in the design of these software products; the third investigated how student autonomy is supported by structures of affect relations in a Montessori elementary classroom. In each of these analyses, the results are clearly applicable to practice. Hence, APT&C is a research methodology that helps link theory to practice.

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Teaching, Technology and Style: A Comparison of Learning Styles and Technology Competencies of Teachers PK-4

Doug Brubaker, Ph.D.
Marti K. Giffin, Ed.D.
Carroll Independent School District

Abstract

In this study the author investigated whether a relationship exists between teachers' learning styles and their self-reported technology related needs, beliefs, stages of adoption, software expertise, and technology competencies. Learning style was identified using the *Gregorc Style Delineator*. The *Snapshot Survey* measured technology related needs, beliefs, stages of adoption, and software expertise, and technology competencies were measured using the *Technology in Education Competency Survey*. The final analysis included data collected from a sample of 499 participants from 12 elementary schools.

The data suggest a significant relationship between learning style and the technology related needs, stages of adoption, software expertise, and competencies of teachers. The relationship between learning style and technology related needs was significant at the $\underline{p} < .01$ level, and between learning style and technology related stages of adoption, software expertise, and technology competencies at the $\underline{p} < .05$.

Possible applications of these findings may include mentor programs and training models that have been individualized to match learning style profiles.

Introduction

Since the beginning of the Industrial Revolution, successive waves of new and domestically developed technologies have fueled economic growth in the United States. Where foreign competition has eroded American predominance in a given field, the dramatic growth of another sector has provided jobs to replace a share of those that have been lost.

The last thirty years of the twentieth century, when many multinational corporations exported factories and jobs to the developing world, provide a key example of this phenomenon. Innovations in computer hardware and software production led to the development of new industries in which a comparatively highly trained, expensive workforce was an asset. Innovators such as Steve Jobs and Bill Gates have played critical roles in the creation of jobs employing millions of American workers.

Now, at the end of the first five years of the new millennium, foreign competition again threatens to siphon jobs away from the United States. According to the American Electronics Association (AEA), "High-tech employment totaled 6 million in 2002, down from 6.5 million in 2001" (p.1). This may be true because a dramatic decrease in the cost of telecommunications and the growth in the number of qualified overseas workers have made it possible for American businesses to develop software more economically and provide technology related support services from foreign countries (Information Technology Association of America [ITAA], 2003.). The ITAA's 2003 survey of 374,129 companies found that twelve percent of companies engaged in IT commerce outsourced jobs overseas. The types of jobs most likely to be sent overseas require more skill and command higher wages than might be expected:

> While offshore development is often considered an alternative for low end "commodity" work, the ITAA survey finds programming/software engineering the job category most likely to go overseas (67%), followed by network design (37%) and web development (30%). In terms of jobs going overseas in the next six months, companies cited programming/software development (35%) and technical support (29%). (ITAA, 2003, p. 12)

This state of affairs may leave one asking about the source of America's next great economic engine. Perhaps because the next generation of innovators and entrepreneurs is currently enrolled in K-12 schools across the country, concern has grown about the need to prepare these students for the competitive environment that they will face. Efforts to provide technology tools and training to them are substantiated, for example, by data from such as the

National Center for Educational Statistics [NCES], which estimates that American schools spend over $5 billion on educational technology (2003).

In some respects, these efforts have been successful. Computers and Internet access currently are much more widely available in schools. Since 1983, the total number of computers in U. S. classrooms is estimated to have grown from less than 50,000 to more than 5.8 million (Mehlinger, 1995; U. S. Congress, Office of Technology Assessment, 1995). Between 1998 and 2000, the percentage of U. S. classrooms connected to the Internet rose from 27% to 63% (Revenaugh, 2000). Between 1996 and 2000, over 1 million classrooms were wired to the Internet (Carvin, 2000; U. S. Congress, Office of Technology Assessment, 1995 as cited in Rovai and Childress, 2002). The growth in federal spending on technology from $21 million in 1995 to $729 million in 2001 has also helped to accelerate access to computers in schools (Russell et al, 2003).

Yet research suggests that student use of computers has not increased. A 1997 study of teachers and administrators sponsored by Jostens Learning Corporation found that teachers were more likely to create documents, spreadsheets, or graphics for "personal productivity" than for instruction (1997, as cited in Earle, 2002). In a recent telephone survey, 39% of middle and high school students said that they "hardly ever" use computers in school (Public Agenda, 2001). The *Snapshot Survey*, conducted with 3,665 teachers in four states, found that 14% of K-12 teachers do not use technology for instruction, and 45% use it for instructional purposes fewer than fifteen minutes per week (Norris et al, 2003).

If there are more computers in classrooms and Internet access is more widely available, why are students not using computers for instructional purposes at a higher rate? If time is not being allocated for the use of instructional technology, it seems advisable to investigate relationships between the skills and beliefs of the people in public schools who are responsible for scheduling the majority of the school day. In self-contained and semi-departmentalized elementary settings, teachers perform this function. As a result, it is possible that the use of educational technology in K-12 environments may be limited by the degree to which classroom teachers embrace it. Teachers may not only avoid using technology for instructional purposes themselves, but also fail to provide opportunities for their students to do so.

So the question becomes, do the learning styles of teachers have a relationship with the degree of comfort and proficiency with which they work with educational technology? Specifically, do the learning styles of teachers relate to the technology related needs, beliefs, levels of adoption, software expertise, and competence related to educational technology? This study was completed to determine whether teachers with the same dominant learning style share similar characteristics with respect to their beliefs about, and proficiency with, educational technology.

Literature Review

The study of learning styles, their interaction with technology use patterns, and their impact on a variety of other technology-related characteristics have generated a considerable volume of research. A significant body of this research explores factors that determine if technology is used in the classroom for instruction. Many of these factors identify the personal characteristics of teachers as possible obstacles to using computers for instructional purposes (Christensen, 2002; Milbrath & Kenzie, 2000; Ropp, 1999).

In a quantitative study of 94 classrooms, Baylor and Ritchie (2002) investigated the impact of the "planning, leadership, curriculum alignment, professional development, technology use, teacher openness to change, and teacher non-school computer use" on student learning and teacher skill and morale (p. 395). Stepwise regression was used to determine which combinations of variables affected one another. The study found that teachers' openness to change and use of technology had an impact on the degree to which those teachers used technology in the classroom for instructional purposes.

Citing the work of other researchers, Earle (2002) identified access, time, training, cultural acceptance, leadership, and technical support as factors that needed to be present to successfully integrate technology into instruction. Knezek et al (2000) used structural equations to formulate and investigate the validity of the *Will-Skill-Tool* model. They found that teachers who have the *will* to use instructional technology, the necessary *skills*, and access to the appropriate hardware and software *tools* are more likely to use technology in the classroom than teachers who do not.

Becker's analysis of the Teaching, Learning, and Computing Survey—a study of over 4,000 teachers of grades four through twelve in over 1,000 American schools—indicated that teachers rated in the top 25% with regard to computer skills, variety of use of computers, and experience working with computers "had students use three times the number of types of software than teachers in the bottom 25% (2000, p. 12).

Dursick (1998) found that "personal social cognitive factors" such as attitude, anxiety, self efficacy, willingness to make time commitment, [willingness to] face risks, competency, beliefs, perceptions of relevance,

and lack of knowledge" have an impact on technology use in the classroom. George and Camarata (1996) attribute the reluctance of teachers to use technology to a lack of confidence in their abilities to do so.

Even though teacher characteristics have been widely identified as factors that have an impact on technology use in schools, the significance of such factors is not universally accepted. Using *Snapshot Survey* data from 3,665 teachers in California, Florida, Nebraska, and New York, Norris et al (2003) found that technology use was almost exclusively a function of access, to the exclusion of the individual differences of teachers. Conlon and Simpson (2003) have also found that individual differences among teachers, with respect to computers, appears to be fading as more computers are found, and frequently used, in teachers' homes in Scotland.

As a result of this ongoing dispute, research on beliefs and personality characteristics is arguably a more pressing need than other factors such as access and staff development. This is because the personal characteristics of teachers may be the more challenging obstacles to address. Instituting additional staff development programs and purchasing more equipment may remedy skill deficits and increase the number of computers available for teachers and students to access. To create high quality staff development programs that promote the use of instructional technology, personal attributes of teachers need to be identified and addressed. Teachers who are forced to experiment independently with new equipment or participate in workshops that do not meet their needs may develop more resistance to technology. People who have experienced frustration in learning to use technology are more likely to be resistant to it or have anxious feelings about it, depending on the reasons that they believe they have failed (George & Camarata, 1996; Martinko, Henry, and Zmud, 1996; Morgan, Morgan, & Hall, 2000). These findings suggest that if an individual participates in training in a manner than does not result in success, initial resistance to technology may be further entrenched.

Cognitive Styles Research

Research in the area of cognitive styles is focused on identifying factors that distinguish the thought processes of one person from those of another. It helps to explain why individuals think and act in different ways when presented with the same types of sensory stimuli. Work in this area began in the late 1800s when psychologists attempted to identify a link between low level, observable cognitive processes such as sensory acuity, finger tapping, and speed reacting to stimuli (Dillon and Watson, 1996).

Early efforts in cognitive styles research sought to explain the role of personality in determining how people think and act. Karl Jung, one of the earliest researchers to explore this field, believed that people learned in different ways partly because of their unique personalities. Jung's model of personality types laid the foundation for the *Myers-Briggs Type Inventory* that is used today (1923, cited by Sternberg and Grigorenko, 1997).

There is an immense amount of material that has been published over the past sixty years related to the concept of cognitive styles. Messick's model identified nine different styles, including scanning, leveling-sharpening, constructed-flexible control, tolerance for incongruous or unrealistic experience, field-dependence, cognitive complexity, reflection-impulsivity, styles of categorization, and styles of conceptualization (Messick 1970, cited in Goldstein and Blackman, 1978). By 1976, his list had grown to nineteen. It is challenging to produce a comprehensive overview of the literature because a complete, coherent, and widely accepted framework does not exist for categorizing the multitude of constructs into a single system. Sternberg notes that this has created problems for researchers in the field:

> ...the styles literature has failed to provide any common conceptual framework language for researchers to communicate either with each other or with psychologists at large...The result is a kind of balkanization of research groups, and balkanization always has led to division and, arguably, deaths of a thousand cuts (2000, p. 250).

The intensity of interest and research activity in the area also appears to be cyclical. In 1978, Goldstein and Blackman cited this interest as a reason for writing their book. Almost twenty years later, Sternberg and Grigorenko speculated that another active era in cognitive styles research may be at hand, musing that cognitive styles, "much like wide neckties," seem to go in and out of fashion on a cyclical basis (1997, p. 701). This further complicates the task of encapsulating all of the relevant research into one review.

Sternberg and Grigorenko (1997) have developed a list of common characteristics that they assert are shared by all valid models of cognitive style (Table 1). They also distinguish between cognition-centered, personality-centered, and activity-centered approaches to cognitive style research (1997). This taxonomy provides a framework for reviewing a diverse field of study, and it has been repeatedly cited in the literature (Cano-Garcia & Hughes, 2000; Rayner & Riding, 1997; Zhang, 2002a; Zhang, 2002b).

Table 1

Characteristics of Valid Cognitive Styles Models

Characteristic	**Description**
Theoretical Specification	The positing of a reasonably complete, well-specified, and internally consistent theory of style that makes connection with extant psychological theory.
Internal Validity	A demonstration by factor analysis or some other method of internal analysis that the underlying structure of the item or subtest data is predicted by theory.
Convergent External Validity	A demonstration that the measures of styles correlate with other measures with which, in theory, they should correlate.
Discriminant External Validity	A demonstration that the measures of styles do not correlate with other measures with which, in theory, they should not correlate.
Heuristic Generativity	The extent to which the theory has spawned and continues to spawn psychological research and, ideally, practical application.

Note. Adapted from "Are cognitive styles still in style?" by Robert J. Sternberg and Elena L. Grigorenko, 1997, *American Psychologist, 52(7)*, p. 703. Copyright 1997 by the American Psychological Association.

Cognitive-Centered Approaches

The field-dependence/field-independence model is an example of a cognitive-centered approach to cognitive styles research whose roots are in the field of psychology. Hayes and Allinson describe this model as "the most thoroughly researched dimension of cognitive style" (1996, p. 67). The researchers explored how subjects were able to determine their physical orientation to the ground without any visual cues (Witkin, Moore, Goodenough & Cox, 1977). They discovered that some people rely on perceptions of the area around them, or the prevailing field, for cues about the structure of their environment. This mode of perception is known as field-dependence. The ability to perceive without cues from the surrounding environment is known as field-independent.

The educational implications of this model are that people with a field-independent learning style should be able to learn with fewer contextual cues, while field-dependent learners will be more likely to rely on them. Witkin et al (1977) was among the first cognitive styles researchers to suggest that teaching and learning styles could be matched to improve student outcomes.

Hayes and Allinson (1996) found that two of six studies using the field-dependence/independence learning style model to investigate the possible effect of matching learning styles on learning outcomes demonstrated a significant relationship. Smith believes the field dependence/independence model favors males from middle and upper class backgrounds (2002). He also argues that the use of Witkin's work to formulate spatial components of IQ tests illustrates how being field independent is perceived as being better than field dependent, because people who demonstrated field independent qualities on an IQ test would earn higher scores (2002).

Activity-Centered Approaches

Although the terms cognitive style and learning style are often considered interchangeable, Sternberg and Grigorenko consider learning style a subset of cognitive style (1997). This designation is based on the assumption that learning is an activity, an assertion made by Kolb in his *Experiential Learning Model*. According to Kolb, the learning process consists of "concrete experience, reflective observation, abstract conceptualization, and active experimentation" (Boyatzis & Kolb, 1991, p. 279). The Kolb *Learning Styles Inventory* [LSI] measures the reliance of an individual on each of the four stages (Takacs, Reed & Wells, 1999). The two most prominent stages for each individual combine to define his or her learning style. Under this model, one may be a diverger, assimilator, converger, or accommodator (Cano-Garcie & Hewitt-Hughes, 2000; Terrell, 2002). Divergers prefer concrete experiences; assimilators "create models for tasks at hand;" convergers conceptualize abstractly and experiment actively; and accommodators learn through processes (Takacs et al, 1999, p. 2).

The Kolb *Learning Styles Inventory* also has been applied in research related to computer users. In an analysis of five studies completed before 1990, Hayes and Allinson (1996) found that all five indicated that there was some interaction between learning style and achievement. Wang, Hinn, and Kanfer (2001) found no significant difference between Kolb learning style groups on an achievement test taken by 31 participants following a class that used a computer program to facilitate online collaboration.

Terrell found that there was a relationship between learning style and completion rate for a sample of 159 doctoral students (2002). Using ANOVA and independent sample t-tests, Terrell cautions that the Kolb LSI has been widely criticized for construct validity (2002). The activity-centered model proposed by Dunn and Dunn is based on the active nature of learning. This model is oriented to the way in which an individual reacts to environmental factors related to the acquisition of new information (Howard, 1998; Kaplan & Kies, 1995; Sims & Sims, 1995).

Raupers (1999) found that teachers performed better on a posttest following a six-hour technology workshop when exposed to a culminating activity designed for their unique learning styles, as assessed using the *Productivity Environmental Preference Survey* [PEPS] (Dunn, Dunn & Price, 1991; Raupers, 1999). This study suggests that technology classes structured to accommodate different learning styles may better meet the needs of adult learners. Sternberg and Grigorenko observe that the Dunn and Dunn model refers "more to elements that affect a person's ability to learn than to ways of learning" (2000, in Sternberg & Zhang, p. 17), such as the temperature of the room and the emotional state of the participants.

Personality-Centered Approaches

Personality-centered approaches include those that, although they may influence or impact cognitive processes, are rooted in personality traits (Sternberg and Grigorenko, 1997). The *Myers-Briggs Type Indicator* [MBTI] is one example of a personality-centered model that is derived from Jung's personality types (Carland,

1990; Myers & McCaulley, 1989). Jung's eight types are based on four individual subscales: introversion and extraversion; sensing and intuitive; thinking and feeling; and judging and perceiving (Catland, 1990). Moreland (1990) asserted that individuals might struggle with technology because of their personality types.

Smith and Munday (1995) found that *intuitive* and *thinking* types of teachers were more willing to use technology than *sensory* types who were considered more practical in their orientation. *Sensory/feeling* types were least likely to be comfortable with technology. Chambers (et al, 2003) used the MBTI and the questionnaire developed by Smith and Munday (1995) to find that *intuitive/thinking* types are most likely to be comfortable with technology, while *sensory/feeling* types were least likely to be comfortable (Chambers et al, 2003).

The *Gregorc Style Delineator* (GSD), also a personality-centered approach to cognitive styles research (Sternberg & Grigorenko, 1997), includes elements of personality and cognition as reflected in behavior. Gregorc explains that "[l]earning style consists of distinctive behaviors which serve as indicators of how a person learns from and adapts to his environment" (1979, p. 234). The combination of attributes that enables one to use a given set of channels to make sense of one's environment is called *mediation ability*, and the behaviors that result from the use of this ability are known collectively as *style* (Gregorc, 1982a, p. 5). The model classifies individuals with respect to how they receive information, which is *perception*, and the way in which they organize it, which is *ordering* (Gregorc, 1982a, p. 5). The synthesis of the two dominant qualities within the perceptual and ordering domains results in the four channels in the Gregorc model. These include concrete sequential [CS], abstract sequential [AS], abstract random [AR], and concrete random [CR] (Gregorc, 1982b).

CS people thrive on structure. They are most comfortable learning skills and completing tasks that are accompanied by step-by-step directions and clear criteria for what is considered mastery or successful completion. Possible positive characteristics include good organization skills and proficiency with handling details. Possible shortcomings of the CS mind style include rigidity and a heavy-handed leadership style characterized by a tendency to micromanage (Gregorc, 1997).

People with the AS mind style are considered more academic, philosophical, and analytical in their orientation. They are thoughtful people who ask questions; they prefer to know why they have been instructed to learn a skill or complete a task as well as how they are supposed to do it. Strengths of AS people may include a deep understanding of their chosen fields and strong analytical skills. Shortcomings may include the perception among others that they have a tendency to fixate on and repeatedly challenge small parts of ideas not perceived to be compatible with their own (Gregorc, 1997).

The AR mind style is closely linked with human emotion. AR people learn skills and perform tasks more readily when they relate well to their teachers or their supervisors. Strengths of ARs may include a gift for interpersonal relations, artistic creativity, and an ability to interpret the feelings of others. The disadvantages include a lack of organization skills, mood swings, and a poorly developed concept of time (Gregorc, 1997).

CR people are likely to be competitive and intuitive innovators. They typically do not enjoy working with details or following routines, and they prefer to learn skills and complete tasks independently. Strengths of CRs may include possessing the attributes of visionary and driven leaders. Their weaknesses may include being overly competitive or taking excessive personal or professional risks (Gregorc, 1997).

A variety of studies have used the Gregorc mind styles model to investigate the relationship between learning style and technology-related attributes. Ross and Shulz (1999) found that learning style did not have a significant impact on learning in a computer assisted instruction [CAI] environment. Ester (1994) found that abstract learners performed significantly better using a lecture approach than they did using a CAI system, but he did not find a significant difference between the achievements of people with different learning styles when the same instructional methods were used.

Ames (2003) found a relationship between learning style and computer attitudes using a shortened form of the *Computer Attitude Scale* (CAS) and the GSD. The study found that AS people were "more confident, less anxious, and more favorably disposed to instruction via computer," while AR and CR learners were "less inclined to be receptive to technology-facilitated instruction" (Ames, 2003, p. 10). Because women in the sample population were more likely to be AR learners, Ames also called for more research into a possible relationship between learning styles and attitudes toward technology.

One consistent finding among these studies is that AR learners do not appear to function as well in environments that involve computer equipment, or learn as well in classes that address computer topics, as other types of learners. This, in turn, suggests that there may be a relationship between the technology-related attributes of teachers and their learning styles.

The literature review illustrates that a relationship may exist between cognitive style and several key technology-related attributes among teachers. Due to the small number of studies that have made use of the GSD, research has been drawn from cognitive-centered, activity-centered, and personality-centered traditions within the

field of cognitive styles research, as identified by Sternberg and Grigorenko (1997). Findings are not universally consistent, but they do provide reason to believe that people with different learning styles may react differently to training based on their styles (Hayes & Allinson, 1997).

No prior studies have been undertaken with elementary school teachers using Gregorc's original methodology with this combination of variables—technology-related needs, beliefs, stages of adoption, software expertise, and technology competencies. The use of an elementary teacher sample is important, based on the findings by Norris et al (2003) that secondary teachers are more likely to use technology instructionally than their elementary colleagues.

Method

Data were collected from 508 teachers employed by the Mansfield Independent School District, a suburban PK-12 school system located within the Dallas-Fort Worth, Texas, metropolitan area. The target population was selected for several reasons. Although the configuration of grade levels varies in schools across the United States, most configurations include grades PK-4 at the elementary level as do the schools in the subject district. The study included PK-4 teachers, reading specialists, and teachers of special education, music, Spanish, art, and physical education. Teachers who were absent on the day of testing, or opted not to participate in the study, were considered non-participants. The results of nine surveys were eliminated from analysis because four were completed by paraprofessionals, two were completed by administrators, and three included incorrectly completed GSDs.

Individual surveys that were not completed properly or did not reflect a dominant learning style were not included in the analysis. As a result, 499 teachers (21 males, 478 females, one of unknown gender) were included in the study. Among them, 253 had a bachelor's degree only, 135 had taken some graduate classes, and 99 had earned a master's degree. Six reported having completed some classes at the doctoral level. Their ages ranged from 20 to 51 and their years of teaching experience ranged from 1 year to 20 years.

Measures

Learning style was assessed using the research version of the GSD, which determines how an individual prefers to receive and process information (Gregorc, 1982). The GSD included ten sets of four words, which participants were asked to rank in order of preference. Each word was identified with a learning style. Sub scores for each learning style were tabulated. A learning style was considered *dominant* if the score was greater than 27 on a learning styles subscale (Gregorc, 1982b).

An adapted version of the *Snapshot Survey* (Norris & Solloway, 1999) was used to assess the needs of teachers related to educational technology, their beliefs about technology, the degree to which they have adopted it for use in the classroom, and the degree of their expertise with commonly used applications. The *Snapshot Survey* consists of three sections. It includes a twelve item needs assessment, an eight item assessment of the respondents' beliefs about technology, the one item *Concern-Based Adoption Model Level of Use* [CBAM LOU] assessment regarding the degree to which teachers have adopted technology in the classroom, and a sixteen item assessment of their software expertise on commonly used applications (Norris & Solloway, 1999). All of the items, with the exception of the CBAM LOU, are scored using a five point Likert type scale (Norris & Solloway, 1999).

The wording of item two on the *Needs Assessment* section of the *Snapshot Survey* was modified to render it more appropriate for the population surveyed. Respondents were asked about the degree to which they "need more time to change the curriculum to better incorporate the technology" (Norris & Solloway, 1999). The *Texas Essential Knowledge and Skills* [TEKS] are the state required learning objectives for all students in the state of Texas and cannot be changed. Because the wording might lead to the impression among the respondents that they were being asked whether they needed to change the TEKS, the item was rewritten to read, "need more time to plan lessons to better incorporate the technology." Cronbach's alpha for the twelve scaled items on the needs component of the *Snapshot Survey* was calculated as .80.

The *Assessment of Software Expertise* was also modified to include more recent software packages that are used for instructional and administrative purposes on elementary campuses in the Mansfield Independent School District. This modified form of the *Assessment of Software Expertise* portion of the *Snapshot Survey*, which includes sixteen items, had a Cronbach's alpha of .83.

The *Technology in Education Competency Survey* [TCES] was used to assess the degree to which teachers perceived themselves to be proficient in the use of technology for educational purposes (Christensen, 1999). It is a self assessment that contains nine items and has demonstrated "an internal consistency reliability estimate of .92 across 188 pre-service educators and 40 university faculty" (Knezek, et al, 2000, p. 39, citing Christensen &

Knezek, 2000). The Institute for the Integration of Technology into Teaching and Learning [IITTL] web site lists the source of the criteria as a survey published by the International Society for Technology in Education [ISTE] (1999). Knezek et al (2000) list the source of the criteria assessed on the survey as the National Council for the Accreditation of Teacher Education [NCATE]. Scores for each subscale on the *Snapshot Survey*, and for the TCES as a whole, were tabulated.

Data Analysis

All statistical data were analyzed using *Statistical Program for the Social Sciences* ® [SPSS] data analysis software for Windows, Version 10.0, 2000. In order to describe the targeted population, descriptive data were generated for the following demographic items: years of teaching experience, gender, years of teaching experience in the Mansfield ISD, teaching assignment, number of credit hours of technology related instruction in teacher certification program, number of clock hours of technology related instruction in other district (if applicable), number of clock hours of technology instruction in the Mansfield ISD, age, highest level of education, and learning style. Descriptive data also included frequencies, means, sample sizes, standard deviations, and variances. The .05 alpha level was applied to all data as the standard for significance.

A one-way analysis of variance [ANOVA] was used to test hypotheses one, two, three, four, and five. Levine's *Homogeneity of Variance Test* was conducted to ensure that differences among the means, related to the measure used, were not sufficiently similar to permit comparison.

Results

ANOVA was used to determine whether significant differences existed between groups of teachers, grades PK-4, with respect to their mean scores on self-assessments related to the following variables: technology-related needs, beliefs about technology, levels of adoption of technology, software expertise, and technology competencies. These procedures indicated that there were significant differences between groups with respect to the needs, stages of adoption, software expertise, and technology competency variables. Tukey HSD post hoc tests were performed for each variable in order to determine which groups, if any, differed significantly from one another. In several cases, the Tukey HSD tests were not effective at identifying differences between specific groups for which the analyses of variance had identified differences. As a result, Fisher LSD tests were conducted on each variable for which the ANOVA found significant differences between the learning style groups.

For the needs variable, the results of the Tukey HSD tests indicated that there were significant differences between the AS and CS groups and between the AS and AR groups. The Fisher LSD post hoc tests also found significant differences between the CS and AS groups and the AS and AR groups.

The ANOVA indicated that there was no significant difference between the four learning style groups on the beliefs variable. No additional analysis was conducted with respect to this variable. The ANOVA detected a significant difference between the learning style groups on the stages of adoption variable. The Tukey HSD post hoc tests failed to identify significant differences between the individual groups. The set of Fisher LSD tests, however, identified significant differences between the following groups: AS and AR; AR and CR; AS and CR.

The ANOVA indicated a significant difference between the learning style groups on the software expertise variable ($p=.014$). The Tukey HSD post hoc tests failed to identify significant differences between the individual groups. Fisher LSD post hoc tests, however, identified significant differences between the following groups: AS and AR; AR and CR.

The ANOVA indicated a difference between the learning style groups on the technology competency variable. The Tukey HSD post hoc tests failed to identify any significant differences between the groups. The Fisher LSD post hoc tests, however, identified differences between the following groups: CS and AS; AS and AR; AR and CR.

Discussion

Data analysis procedures were complicated by the failure of the Tukey HSD post hoc test to pinpoint differences among specific groups that had been identified by analyses of variance. As a result, the Fisher LSD was utilized as a post hoc test to identify differences between groups on variables for which an ANOVA had identified a significant difference. The findings for each variable are discussed with respect to the findings of each test on each variable.

On the needs variable, both the Tukey HSD and the Fisher LSD tests indicated that there was a significant difference between the means scores of the AS, CS, and AR groups. Only the Fisher LSD test detected a difference between the AS and CR groups. The mean scores for the AS group were higher than those for the other groups.

For the stages of adoption variable, the Tukey HSD failed to identify any differences between groups. Fisher LSD tests indicated that there was a significant difference between the AS and AR groups and the AR and CR groups. The mean scores for the AS group were higher than those of the AR group. The CR scores were significantly higher than the CR group.

For the stages of adoption variable, the Tukey HSD and Fisher LSD tests indicated that there was a significant difference between the CS and AS groups. The Fisher LSD found differences for this variable between the AS and CS groups, the AS and AR groups, and AR and CR groups. The scores for the AS group were significantly higher than those of the AR and CS groups. The CR scores were significantly higher than those of the AR group.

It was determined that AS teachers reported significantly lower needs than their CS, AR, and CR colleagues. AS teachers had significantly higher stages of adoption than AR teachers, and CR teachers were determined to have significantly higher stages of adoption than AR learners. In addition, it was determined that AS teachers reported significantly higher levels of technology competency than CS or AR teachers. CR teachers also reported significantly higher levels of competency than AR teachers.

Summary

Perhaps it is possible that an approach to technology staff development that takes into account the uniqueness of teachers might have a favorable impact on teaching and learning with technology. The AS group, which accounts for the smallest percentage of teachers in the sample (7.6%), had the fewest technology-related needs, highest stages of adoption, and more developed technology competencies. Further research is needed to determine why AS teachers, as noted in several previous studies, appear to be more adept and enthusiastic users of computers than their CS and AR counterparts.

The findings of the current study, especially when coupled with the findings of previous research, also suggest that AR and CS learners may struggle more with using technology in instructional settings. Compared to AS teachers, CS and/or AR teachers had scores that reflected greater need or lower proficiency on each of the variables studied in the course of this investigation. This finding has significant implications. CS and AR groups jointly accounted for 67.2% of all teachers in the sample used in the current study. If the results of the current study can be generalized to teachers of grades PK-4, the majority of teaching personnel who are responsible for teaching students about technology may be less adept at performing this function than a much smaller group of their colleagues.

Accordingly, the following recommendations have been made for further research regarding the relationship between learning styles, as identified by the GSD, and technology-related attributes of teachers:

1. Explore the reasons that AS and, to a lesser degree, CR learners appeared to have significantly fewer needs and significantly higher stages of adoption and technology competencies than CS and/or AR learners.
2. Conduct a study that places participants in treatment groups based on their dominant learning styles. Investigate whether instructional strategies designed for their dominant learning styles have an impact on their mastery of technology-related knowledge and skills.
3. Replicate this study with a group of secondary teachers to determine if there are any differences between teachers in intermediate, middle, and high school settings.

It is hoped that by continuing to investigate the learning styles of teachers, technology staff development can be improved. If staff development strategies can be tailored to meet the needs of the teachers who attend them, perhaps teachers will become more effective in facilitating instruction using instructional technology.

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An Assessment of Undergraduate Student's Mobility Skills and Needs in Curriculum Delivery

Dale Higginbotham
University of Houston

Abstract

The most important characteristic of our society in the last three decades may well be the incredible speed with which it changes. Scientific, technological, social and cultural innovation are taking place at such a fast pace, students constantly need to revise their skills in order to adapt to the changing technologies. In our day-to-day lives communication mobility not only effects interpersonal communication and entertainment but has become equally important in succeeding in ones pursuit of higher education.

Today we are living in a wireless world. Mobile communication devices (e.g., iPods, cell phones, laptop computers, PDAs) are expanding the scope of education and learning. As Bryan Alexander noted in his article, *Going nomadic: Mobile learning in higher education,* such devices foster mobile learners, or "m-learners"--students who are constantly connected. M-learners engage in "m-learning," rapid, just-in-time learning, fueled by feedback and the capability for shared and multi-way communications. Thus, students can instantly construct their own learning environments (Alexander 2004).

But along with the positive aspects of technology also comes the negative. How much can one student absorb while being involved in other activities? Linda Stone, a former Microsoft researcher, characterizes ours as an era of "continuous partial attention." At the extreme end are the traditional students instant-messaging while they talk on the cellphone, download music and do homework. But non-traditional students too live with all systems go, interrupted and distracted, scanning everything, multi-technological-tasking everywhere. We suffer from the illusion, says Stone that we can expand our "personal bandwidth", connecting to ever more important information. Instead, we end up over stimulated, overwhelmed and unfulfilled. Continuous partial attention inevitably feels like a lack of full attention" (Stone, 2005).

How much information can be too much information? The term "Information overload" was coined in 1970 by Alvin Toffler in his book, *Future Shock*. Information overload refers to the state of having too much information to make a decision or remain informed about a topic. This term is normally used in conjunction with various forms of computer-mediated communication. Large amounts of currently available information, a high rate of new information being added, contradictions in available information, a low signal-to-noise ratio, and inefficient methods for comparing and processing different kinds of information can all contribute to this effect (Toffler, 1970). In a world where information overload is common, attention is a very scarce resource and there is an increasing need to manage it efficiently. In a connected world it is becoming very difficult to filter out the information that really needs our attention from that which is irrelevant to us.

The Study

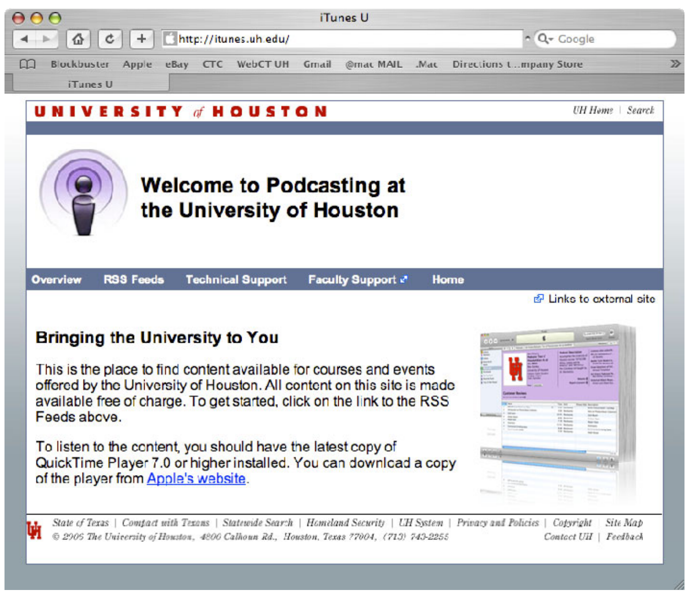
The research data is from Phase I of an ongoing research study, funded by the University of Houston's Educational Technology and University Outreach. Which involved students enrolled in multiple classes in the field of communication. The students attended either traditional face-to-face classes or fully online courses. Instructors used Podcasting and Vodcasting to deliver course lecture materials or supplement materials as an alternative channel to facilitate student learning. Survey research methods were used to conduct the study. The study specifically investigated the areas listed below related to Podcasting and Vodcasting of course content materials while multitasking:

1. The use of portable media devices (PMD) – iPods/Mp3 players to access instructional materials while involved in other activities
   a) The time duration for their use while multitasking

b) The frequency of use while multitasking
c) The purpose they use portable devices while multitasking

2. Podcasting course materials
   a) The hours students spend viewing/listening to Podcasting materials while multitasking
   b) The delivery quality of Podcasting materials while multitasking
   c) The technical issues related to the Podcasting delivery while multitasking
   d) Students' preferred Podcasting format, audio/video/still image, etc., while multitasking
3. Podcasting learning styles and study habits
   a) The availability of Podcasting course materials changes study habits because of their ability of use while multitasking
   b) Podcasting delivery format and the enhancement of learning experiences while multitasking
   c) Podcasting delivery format and personal learning style as developed during multitasking
   d) Podcasting and mobile learning perceptions while multitasking
   e) Students mobility needs
4. Podcasting and learning effectiveness
   a) How well does the student retain information while multitasking
   b) The helpfulness of the addition of Podcasting course material as available resources to the understanding of course content
   c) Podcasting and improvement of leaning outcome

Study Results



Demographics

The University of Houston is a large urban university with over 35,000 students. The majority of our students are non-traditional commuter students. In this study our population is made up of 62% female/38% male and the majority was between 20 -25 years of age (Tables 1-2). We found that a 41% majority of the students commuted 20 or more miles to campus (Table 6), with a typical commute between 21-50 minutes one-way (Table 7).

The formats of the courses studied were: Traditional face-to-face, no online usage; traditional face-to-face; some online usage; hybrid/bended class – 50% or more online; and fully online with the majority of the students were in traditional face-to-face with some online usage (Table 8). The majority of the students accessed their course materials from home using high speed (Cable or DSL) internet connections (Tables 3-4). In measuring their computer competency a majority of 63% of the students have been using computers for eight or more

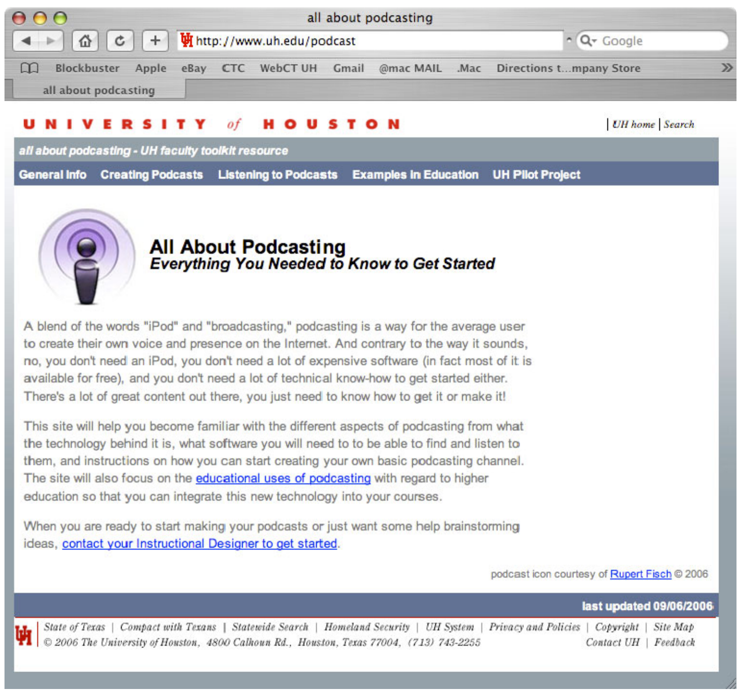
years (Table 5). Given the age, level of technology expertise and the technology they have at their disposal we concluded that our population would be extremely adaptable to new technologies.

Podcasting being a very new technology, we asked the students if before entering their courses they new what a podcast was. 58% percent of the students did but only 31% had ever viewed or listened to one (Tables 9-10).

Use of Portable Media Devices (PMD)

A 38% majority of the students studied responded that they use their PMDs 5 hours or less a week (Tables 11& 14). When asked when the study subjects preferred to use their PMDs the majority answered that they used them while engaged in other activities such as exercising or driving (Tables 12 & 15). Also the majority of the students studied indicated that the activity that they engaged in the most with their PMDs was listening to music (Table 13 & 16).

Use of Podcasting Course Materials



34% of the study population replied that they accessed instructional materials using their PMDs while involved in other activities (Table 17). But when asked if they would access instructional materials in the future with their PMDs a 67% majority said they would (Table 18). When asked how many hours a week they spent using their PMD to access instruction materials while involved in other activities an 81% majority said that they used it less than 5 hours a week (Table 19). This data would indicate that because this technology is so new the students have been conditioned to use it solely for entertainment and would need to be shown that it could have educational purposes especially while multitasking.

When surveyed concerning the quality of PMDs to access instruction materials while involved in other activities 69% approved (Table 20). At the same time 88% responded that they did not have any technical issues related to their PMDs use (Table 21). When asked if the student was an auditory, visual or tactile learner the students responded that they were mainly visual or tactile learners (Table 31). There was an even split in preferences between audio, audio with image and video podcasts (Table 22).

Podcasting Learning Styles and Study Habits

An even split occurred when respondents were asked if they preferred podcasts to attending lectures (table 35 & 36). Instead they preferred the combination of PMD course delivery with face-to-face classroom

experience (Table 37). Also the students were evenly divided when asked why they used the podcast material and if the podcasts changed their study habits (Table 26 & 27). Along the same lines, they were divided when asked that the podcasts changed their behaviors outside of the classroom when studying for exams (Table 28). The students reading time was not effected by including the podcasts in their course delivery (Table 38 & 39) and their total study time was also unaffected (Table 40 & 41).

The majority of the students studied felt that the podcast delivery format enhanced their learning experience and made learning more enjoyable (Table 29 & 30). Concerning the student's mobility needs the majority of the respondents felt that they preferred the mobility that PMDs provided and they found that the ability to review materials whenever they wanted was the most important feature (Tables 33 & 34).

Podcasting and Learning Effectiveness

Concerning information retention while using PMDs to access instructional materials while multitasking, the majority of those surveyed responded that it had a positive effect (Table 23), as well as when asked of their understanding of course content (Table 24). Overall the students felt the addition of the podcast course material would make an improvement to their learning outcome (Table 25).

Conclusions

In conducting our research at a large urban university where the typical student is non-traditional with many time restraints, we have concluded that using PMDs to access instructional materials would be most beneficial, especially in conjunction with their other daily activities.

With long commutes valuable time is lost from our student's day. This time could be better spent studying their course work. Also during other activities such as exercising, students could be multitasking with their course work as well.

Our study has shown us that podcasting technology is easy to access and easy to use. The flexibility and portability of having course materials recorded allows the student to be able to review these materials wherever and whenever they want to and at their own pace. In the traditional lecture this information is heard once and then lost. With this technology the student will be able to review this information as many times as they like in order to reinforce it. We have found that by incorporating PMDs into a student's course materials the student's study habits will change and it will also enhance their learning experience. The format of podcasting material, audio/video/still image would depend on the student's individual learning style.

With the introduction of new technologies earlier in the student's education our student body is more technologically savvy than ever before. With these skills developed at an early age our students today are more adaptable to new technologies and are able to converge them into their everyday lives. Because of the ability to multitask, podcasting engages students and increases their potential to perform better in their overall learning. Because of this adaptability our research indicates that the student has a greater ability to retain information while multitasking.

Students today have very specific mobility needs. Balancing their work and families while trying to obtain an education leaves very little leisure time. Having more tools made available to these students will create a better perception of their educational outcome. The better the student perceives their educational outcome the greater are their chances of succeed.

Further Study

The next phase of our study will involve students that will represent other areas of instruction taught at the University of Houston. Our initial study only involved students studying Communication but our next phase will include students majoring in Science and Mathematics as well as the Arts. We purpose to study how these different backgrounds will effect how the student is able to adapt and utilize this technology in their education Also we plan to study how the podcasting technology must be adapted inorder to fulfill the different instructional needs of these different areas of study.

Table 1
S1:Q1 – Age Groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under 20	17	10.6	10.6	10.6
	20 – 25	120	74.5	74.5	85.1
	26 – 30	18	11.2	11.2	96.3
	31 – 35	2	1.2	1.2	97.5
	36 – 40	3	1.9	1.9	99.4
	41 – above	1	.6	.6	100.0
	Total	161	100.0	100.0	

Table 2
S1 - Q2: Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	99	61.5	61.5	61.5
	Male	62	38.5	38.5	100.0
	Total	161	100.0	100.0	

Table 3
S1 - Q3: What kind of internet connection(s) do you have?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Phone line dial-up	19	11.5	11.5	11.5
	High speed (Cable, DSL)	133	80.6	80.6	92.1
	T1/LAN/WAN	11	6.7	6.7	98.8
	Other	2	1.2	1.2	100.0
	Total	165	100.0	100.0	

Table 4
S1 - Q4: From what location do you access the internet most?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Campus	28	17.4	17.5	17.5
	Home	124	77.0	77.5	95.0
	Workplace	8	5.0	5.0	100.0
	Total	160	99.4	100.0	
Missing	System	1	.6		
Total		161	100.0		

Table 5
S1 - Q5: How long have you been using computers?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	–2 years	1	.6	.6	.6
	2 – 4 years	6	3.7	3.8	4.4
	5 – 8 years	52	32.3	32.5	36.9
	8+ years	101	62.7	63.1	100.0
	Total	160	99.4	100.0	
Missing	System	1	.6		
Total		161	100.0		

Table 6
S1 - Q6: How far do you live from campus?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I live on campus	13	8.1	8.1	8.1
	1 – 5 miles	22	13.7	13.7	21.7
	6 – 10 miles	20	12.4	12.4	34.2
	11 – 15 miles	11	6.8	6.8	41.0
	16 – 20 miles	29	18.0	18.0	59.0
	20+ miles	66	41.0	41.0	100.0
	Total	161	100.0	100.0	

Table 7
S1 - Q7: How long is your typical commute to campus?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	–10 minutes	33	20.5	20.8	20.8
	11 – 20 minutes	24	14.9	15.1	35.8
	21 – 30 minutes	25	15.5	15.7	51.6
	31 – 40 minutes	40	24.8	25.2	76.7
	41 – 50 minutes	25	15.5	15.7	92.5
	60+ minutes	12	7.5	7.5	100.0
	Total	159	98.8	100.0	
Missing	System	2	1.2		
Total		161	100.0		

Table 8
S1 - Q8: What is the format of the course you are currently taking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Traditional face-to-face class, no online usage	22	13.7	13.8	13.8
	Traditional face-to-face class, some online usage	101	62.7	63.1	76.9
	Hybrid/Blended class, (50% or more online)	9	5.6	5.6	82.5
	Fully online course	28	17.4	17.5	100.0
	Total	160	99.4	100.0	
Missing	System	1	.6		
Total		161	100.0		

Table 9
S2 - Q1: Did you know what a podcast was before you took this course?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	73	57.5	57.5	57.5
	No	54	42.5	42.5	100.0
	Total	127	100.0	100.0	

Table 10
S2 - Q2: Did you ever listen to a podcast before you took this course?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	31.5	31.5	31.5
	No	87	68.5	68.5	100.0
	Total	127	100.0	100.0	

Table 11
S2 - Q4: How many hours do you use your iPod a week?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Over 50 hours a week	1	1.1	1.1	1.1
	40-50 hours a week	4	4.2	4.2	5.3
	30-40 hours a week	4	4.2	4.2	9.5
	20-30 hours a week	11	11.6	11.6	21.1
	10-20 hours a week	22	23.2	23.2	44.2
	5-10 hours a week	18	18.9	18.9	63.2
	Less than 5 hours	35	36.8	36.8	100.0
	Total	95	100.0	100.0	

Table 12
S2 - Q5: When do you prefer to use your iPod?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	At home	42	18.4	18.4	18.4
	Driving in the car	46	20.2	20.2	38.6
	Walking or jogging	62	27.2	27.2	65.8
	In public location	37	16.2	16.2	82.0
	Traveling	41	18.0	18.0	100.0
	Total	228	100.0	100.0	

Table 13
S2 - Q6: What activities do you do most with your iPod?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Listen to music	85	65.9	65.9	65.9
	Watch video	14	10.9	10.9	76.7
	Listen to radio	10	7.8	7.8	84.5
	Access RSS news	1	.8	.8	85.3
	Access course materials	10	7.8	7.8	93.0
	Access Podcast news	9	7.0	7.0	100.0
	Total	129	100.0	100.0	

Table 14
S3 - Q2: How many hours do you use your MP3 player a week?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Over 50 hours a week	2	3.6	3.6	3.6
	40-50 hours a week	1	1.8	1.8	5.5
	20-30 hours a week	11	20.0	20.0	25.5
	10-20 hours a week	9	16.4	16.4	41.8
	5-10 hours a week	11	20.0	20.0	61.8
	Less than 5 hours	21	38.2	38.2	100.0
	Total	55	100.0	100.0	

Table 15
S3 - Q3: When do you prefer to use your MP3 player?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	At home	22	20.2	20.2	20.2
	Driving in the car	18	16.5	16.5	36.7
	Walking or jogging	29	26.6	26.6	63.3
	In public location	22	20.2	20.2	83.5
	Traveling	18	16.5	16.5	100.0
	Total	109	100.0	100.0	

Table 16
S3 - Q4: What activities do you do most with your MP3 player?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Listen to music	50	66.7	66.7	66.7
	Watch video	7	9.3	9.3	76.0
	Listen to radio	10	13.3	13.3	89.3
	Access RSS news	1	1.3	1.3	90.7
	Access course materials	4	5.3	5.3	96.0
	Access Podcast news	3	4.0	4.0	100.0
	Total	75	100.0	100.0	

Table 17
S4 - Q1: Did you use your iPod/MP3 player to access instructional materials while involved in other activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	47	33.8	33.8	33.8
	No	92	66.2	66.2	100.0
	Total	139	100.0	100.0	

Table 18
S4 - Q2: If not, would you use iPod/MP3 player to access instructional materials while involved in other activities if it were available to you?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	75	67.6	67.6	67.6
	No	36	32.4	32.4	100.0
	Total	111	100.0	100.0	

Table 19
S4 - Q3: How many hours did you spend in using your iPod/MP3 player to access instructional materials while involved in other activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	40-50 hours a week	1	.8	.8	.8
	30-40 hours a week	1	.8	.8	1.6
	20-30 hours a week	2	1.6	1.6	3.3
	10-20 hours a week	3	2.4	2.4	5.7
	5-10 hours a week	16	13.0	13.0	18.7
	Less than 5 hours	100	81.3	81.3	100.0
	Total	123	100.0	100.0	

Table 20
S4 - Q6: How would you rate the quality of portable media devices (e.g. iPod, MP3 player, etc.) to access instructional materials while involved in other activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	29	22.3	22.3	22.3
	Good	61	46.9	46.9	69.2
	Poor	4	3.1	3.1	72.3
	Bad	2	1.5	1.5	73.8
	N/A	34	26.2	26.2	100.0
	Total	130	100.0	100.0	

Table 21
S4 - Q8: Did you have any technical issues related to the use of portable media devices to access instructional materials while involved in other activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	12.5	12.5	12.5
	No	98	87.5	87.5	100.0
	Total	112	100.0	100.0	

Table 22
S4 - Q9: What is your preferred format of podcasts when you use portable media devices to access instructional materials while involved in other activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Audio	41	33.9	33.9	33.9
	Audio with image	37	30.6	30.6	64.5
	Video	43	35.5	35.5	100.0
	Total	121	100.0	100.0	

Table 23
S4 - Q10: How well did you retain information while using portable media devices to access instructional materials while involved in other activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Well	9	6.6	6.9	6.9
	Well	54	39.4	41.5	48.5
	N/A	49	35.8	37.7	86.2
	Little	16	11.7	12.3	98.5
	Not at all	2	1.5	1.5	100.0
	Total	130	94.9	100.0	
Missing	System	7	5.1		
	Total	137	100.0		

Table 24
S4 - Q11: How helpful did you feel the addition of podcasting course material was to your understanding of course content?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very helpful	21	15.3	15.4	15.4
	Helpful	63	46.0	46.3	61.8
	N/A	35	25.5	25.7	87.5
	Little helpful	12	8.8	8.8	96.3
	No help at all	5	3.6	3.7	100.0
	Total	136	99.3	100.0	
Missing	System	1	.7		
Total		137	100.0		

Table 25
S4 - Q12: How helpful did you feel the addition of podcasting course material was to the improvement of your learning outcome?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very helpful	15	10.9	11.3	11.3
	Helpful	60	43.8	45.1	56.4
	N/A	36	26.3	27.1	83.5
	Little helpful	13	9.5	9.8	93.2
	No help at all	9	6.6	6.8	100.0
	Total	133	97.1	100.0	
Missing	System	4	2.9		
Total		137	100.0		

Table 26
S5 - Q6: I viewed podcast course materials due to following reason(s)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Required content in other formats	16	3.8	3.8	3.8
	Missed lectures	59	14.0	14.0	17.8
	Making up missing notes from class	46	10.9	10.9	28.7
	Course content preview	21	5.0	5.0	33.7
	Course content review	58	13.8	13.8	47.5
	Convenient access	62	14.7	14.7	62.2
	Flexibility	61	14.5	14.5	76.7
	Portability	42	10.0	10.0	86.7
	Ease of use	56	13.3	13.3	100.0
	Total	421	100.0	100.0	

Table 27
S6 - Q1: The availability of course material podcasts changed my study habits.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	7	4.6	4.6	4.6
	Agree	42	27.6	27.8	32.5
	N/A	45	29.6	29.8	62.3
	Disagree	51	33.6	33.8	96.0
	Strongly Disagree	6	3.9	4.0	100.0
	Total	151	99.3	100.0	
Missing	System	1	.7		
Total		152	100.0		

Table 28
S6 - Q2: Podcasting changed my behaviors outside of the classroom when studying for exams.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	5	3.3	3.3	3.3
	Agree	41	27.0	27.0	30.3
	N/A	43	28.3	28.3	58.6
	Disagree	57	37.5	37.5	96.1
	Strongly Disagree	6	3.9	3.9	100.0
	Total	152	100.0	100.0	

Table 29
S6 - Q3: The podcast delivery format enhanced my learning experiences.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	11	7.2	7.3	7.3
	Agree	67	44.1	44.7	52.0
	N/A	44	28.9	29.3	81.3
	Disagree	24	15.8	16.0	97.3
	Strongly Disagree	4	2.6	2.7	100.0
	Total	150	98.7	100.0	
Missing	System	2	1.3		
Total		152	100.0		

Table 30
S6 - Q4: Podcast delivery format made learning more enjoyable.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	13	8.6	8.7	8.7
	Agree	65	42.8	43.3	52.0
	N/A	46	30.3	30.7	82.7
	Disagree	22	14.5	14.7	97.3
	Strongly Disagree	4	2.6	2.7	100.0
	Total	150	98.7	100.0	
Missing	System	2	1.3		
Total		152	100.0		

Table 31
S6 - Q5: Which of the following statements best describes your learning style?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Auditory learner	23	15.1	15.2	15.2
	Visual learner	66	43.4	43.7	58.9
	Tactile learner	62	40.8	41.1	100.0
	Total	151	99.3	100.0	
Missing	System	1	.7		
Total		152	100.0		

Table 32
S6 - Q6: Which of the following podcast formats suited your personal learning style?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Audio podcasts	27	19.7	20.1	20.1
	Podcasts with audio and still images	29	21.2	21.6	41.8
	Video podcasts	78	56.9	58.2	100.0
	Total	134	97.8	100.0	
Missing	System	3	2.2		
Total		137	100.0		

Table 33
S6 - Q7: Which of the following features of podcasts did you find most valuable?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ability to review materials wherever I wanted.	29	21.2	22.1	22.1
	Ability to review materials whenever I wanted.	80	58.4	61.1	83.2
	Ability to review materials at my own pace.	22	16.1	16.8	100.0
	Total	131	95.6	100.0	
Missing	System	6	4.4		
Total		137	100.0		

Table 34
S6 - Q8: I prefer the mobility that the iPod/MP3 player provides.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	41	27.3	27.7	27.7
	Agree	67	44.7	45.3	73.0
	N/A	33	22.0	22.3	95.3
	Disagree	6	4.0	4.1	99.3
	Strongly Disagree	1	.7	.7	100.0
	Total	148	98.7	100.0	
Missing	System	2	1.3		
Total		150	100.0		

Table 35
S6 - Q10: I prefer podcasts for course delivery to attending lectures.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	22	14.4	14.4	14.4
	Agree	40	26.1	26.1	40.5
	N/A	30	19.6	19.6	60.1
	Disagree	37	24.2	24.2	84.3
	Strongly Disagree	24	15.7	15.7	100.0
	Total	153	100.0	100.0	

Table 36
S6 - Q11: I did not use the iPod/MP3 player at all because I learn better from the face-to-face classroom experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	16	10.7	10.7	10.7
	Agree	31	20.8	20.8	31.5
	N/A	47	31.5	31.5	63.1
	Disagree	51	34.2	34.2	97.3
	Strongly Disagree	4	2.7	2.7	100.0
	Total	149	100.0	100.0	

Table 37
S6 - Q12: I prefer the combination of iPod/MP3 player course delivery with the face-to-face classroom experience.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	28	18.8	18.9	18.9
	Agree	69	46.3	46.6	65.5
	N/A	20	13.4	13.5	79.1
	Disagree	24	16.1	16.2	95.3
	Strongly Disagree	7	4.7	4.7	100.0
	Total	148	99.3	100.0	
Missing	System	1	.7		
Total		149	100.0		

Table 38
S6 - Q14: My reading time decreased with the addition of podcasts.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	6	4.0	4.1	4.1
	Agree	39	26.0	26.5	30.6
	N/A	49	32.7	33.3	63.9
	Disagree	44	29.3	29.9	93.9
	Strongly Disagree	9	6.0	6.1	100.0
	Total	147	98.0	100.0	
Missing	System	3	2.0		
Total		150	100.0		

Table 39
S6 - Q15: My reading time increased with the addition of podcasts.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	1	.7	.7	.7
	Agree	17	11.3	11.5	12.2
	N/A	54	36.0	36.5	48.6
	Disagree	58	38.7	39.2	87.8
	Strongly Disagree	18	12.0	12.2	100.0
	Total	148	98.7	100.0	
Missing	System	2	1.3		
Total		150	100.0		

Table 40
S6 - Q16: My studying time decreased with the addition of podcasts.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	4	2.7	2.7	2.7
	Agree	31	20.7	20.8	23.5
	N/A	49	32.7	32.9	56.4
	Disagree	60	40.0	40.3	96.6
	Strongly Disagree	5	3.3	3.4	100.0
	Total	149	99.3	100.0	
Missing	System	1	.7		
Total		150	100.0		

Table 41
S6 - Q17: My studying time increased with the addition of podcasts.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	2	1.3	1.3	1.3
	Agree	27	18.0	18.0	19.3
	N/A	52	34.7	34.7	54.0
	Disagree	56	37.3	37.3	91.3
	Strongly Disagree	13	8.7	8.7	100.0
	Total	150	100.0	100.0	

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The Effects of ARCS-based Confidence Strategies on Learner Confidence and Performance in Distance Education

Jason Bond Huett, Ph.D.
University of West Georgia

Leslie Moller, Ph.D.
University of South Dakota

Marty Bray, Ph.D.
University of West Georgia

Jon Young, Ph.D.
University of North Texas

Kimberly Cleaves Huett, M.S.
Carrollton, GA

Abstract

The purpose of this research was to manipulate the component of confidence found in Keller's ARCS Model to enhance the confidence and performance of undergraduate students enrolled in an online course at a Texas University. This study also tested whether the confidence tactics had any unintentional effect on the remaining attention, relevance, and satisfaction subscales of the ARCS model and learners' overall motivation for the class and the instructional materials. The results indicated that the treatment group showed statistically greater gains than the control group in terms of learner confidence on the CIS but not the IMMS. The treatment group outperformed the control group on all of the individual posttest measures and on the overall mean performance score. The results showed no statistically significant difference on the attention subsection. However, statistically significant differences were noted for the relevance and satisfaction subscales. There was also a statistically significant difference in overall learner motivation as measured on both surveys.

Introduction

Motivation is a highly important yet under-researched aspect of learning. Means, Jonassen, and Dwyer (1997) cited studies showing that motivation accounted for 16% to 38% of the variations in overall student achievement. However, an extensive review of the literature leads one to concur that there is a noted lack of research concerning the motivational needs of learners (Astleitner & Keller, 1995; Gabrielle, 2003; Means, Jonassen & Dwyer, 1997; Shellnut, Knowlton & Savage, 1999; Visser & Keller, 1990).

This is particularly true in terms of computer and web-based instruction. Keller (1999a) noted that self-directed learning environments, like distance education classes, posed greater challenges to learner motivation than their face-to-face counterparts. Song and Keller (2001) advised that continued problems with learner motivation in web or site-based Computer Assisted Instruction (CAI) were often the result of incorrect assumptions on the part of instructional designers that motivation, if taken into account at all, was assumed to be already present in the

CAI. They also noted that with the widespread use of computers in education, one could no longer depend on the "novelty effect" of technology to stimulate learner motivation.

Distance education environments provide unique challenges for instructors and designers who wish to motivate students. Traditional distance learning models stress the independence of the learner (Downs & Moller, 1999; Moore, 1989) and the privatization of the learning environment (Keegan, 1986; Moller, et. al. 2005). Such student-centered, independent learning requires a strong sense of motivation and confidence. Researchers may not being paying enough attention to the motivational requirements of online learners.

For example, in an in-depth study of the proceedings of the World Conferences of the International Council for Distance Education from 1988 to 1995, Visser, Plomp, Amirault, and Kuiper (2002) found that only six of 801 studies addressed motivational concerns of online learners. They also noted that a disturbing "trend in the lack of attention paid to motivation in distance education is present in some of the recently published specialized handbooks in the field of distance education" (p. 95).

Keller's ARCS Model and Previous Studies

To stimulate and manage student motivation to learn, Keller (1987a, 1987b, 1987c) created the ARCS Model of Motivation. ARCS stands for Attention, Relevance, Confidence and Satisfaction and serves as the framework for the motivational and confidence-enhancing tactics found in this study.

Keller's ARCS model enjoys wide support in the literature, and a number of researchers attest to its reliability and validity in many different learning and design environments. For example, ARCS research can be found concerning the traditional classroom (Bickford, 1989; Klein & Freitag, 1992; Means, Jonassen & Dwyer, 1997; Moller, 1993; Naime-Diefenbach, 1991; Small & Gluck, 1994; Visser & Keller, 1990), Computer Assisted Instruction (Asteitner & Keller, 1995; Bohlin & Milheim, 1994; ChanLin, 1994; Lee & Boling, 1996; Shelnut, Knowlton & Savage, 1999; Song, 1998; Song & Keller, 1999; Suzuki & Keller, 1996), blended learning environments (Gabrielle, 2003), and online, distant, and web-based classrooms (Chyung, 2001; Huett, 2006; Song, 2000; Visser, 1998). In fact, Means, Jonassen, and Dwyer (1997) called Keller's ARCS model the "only coherent and comprehensive instructional design model accommodating motivation" (p. 5).

The ARCS model was initially predicated on the *Expectancy Value Theory* based on the work of Tolman (1932) and Lewin (1938). The Expectancy Value Theory essentially states that learners pursue activities they value and in which they expect to succeed (Keller, 1987c). The ARCS model is an attempt to synthesize behavioral, cognitive, and affective learning theories and demonstrate that learner motivation can be influenced through external conditions such as instructional materials (Moller, 1993).

To quote Keller (1987a), "motivational interventions can be focused within a general category, or specific subcategory of the model" (p. 6). However, there is insufficient evidence to support such claims that learner motivation can be isolated or compartmentalized into separate categories. Studies of ARCS-enhanced instructional materials have returned inconsistent results on the individual subsections as well as on the overall measure of learner motivation. Means, Jonassen, and Dwyer (1997) found that "there is inconsistent evidence that each of the factors operates independently, that learners' motivations can be decomposed and isolated, or that

changes in one motivational state have an inconsequential effect on others" (p.6). For example, Naime-Diefenbach (1991) specifically targeted increases in learner attention and confidence and claims her study "validated the attention component of the ARCS model under controlled conditions" (p.50). However, she was not successful in isolating and validating confidence.

Also, Moller (1993) was unsuccessful in isolating and validating increases in confidence for the treatment group in a study specifically designed to do so. Though overall motivation, performance, and self-directed learning were the targets of Gabrielle's (2003) study, she found mixed returns on the confidence subsection. Her results indicated a significant difference between groups as regards confidence on one survey measure but not the other. In a study designed *only* to enhance the relevance subsection of the ARCS model, Babe (1995) also found statistically significant differences between groups for all subsections (attention, relevance, confidence, and satisfaction).

The results of this study (and those mentioned above) continue to challenge researchers' assumptions (Keller, 1987a; Naime-Diefenbach, 1991) that individual components of the ARCS model can be isolated for improvement.

The major focus of this study was to determine whether confidence could be specifically targeted for improvement and whether improvements in confidence would translate into overall motivation and performance gains. The underlying assumptions are that confidence is a highly important aspect of motivation, that it can be manipulated through external factors, and that it has an effect on learner performance.

Confidence

Confidence has been described in the literature as a personality trait (McKinney, 1960). However, confidence is more universally accepted as situation-specific, and it can therefore be manipulated by internal and external factors (Keller, 1979; Moller 1993).

In his development of *Social Learning Theory*, Rotter (1954) argued that people have a tendency to ascribe their failures or successes to internal or external factors: he found that people tend to pursue that which brings about the most rewarding consequence, which he called *expectancy*. Bandura (1977; 1986) elaborated on this concept when he explained that individuals' expectancy is related to their estimate of the outcome of a given behavior. He used the term *self-efficacy* to describe the belief that one's abilities and knowledge are sufficient to be successful at a given task: learners who expect to succeed demonstrate more confidence than learners who expect to fail. However, a learner may still possess confidence without the guarantee of success, as long as the challenge is "within acceptable boundaries" (Naime-Diefenbach, 1991, p. 12).

Building on the work of Rotter, Bandura, and others, Keller defines confidence as "helping the learners believe/feel that they will succeed and control their success" (Keller, 1987a, p. 2). Confidence is the interplay between desire for success and fear of failure. These opposing forces vie for control over the learning experience. To better understand the role of confidence, Keller and Suzuki (1988) characterize its three most important dimensions: perceived competence, perceived control, and expectancy for success.

Perceived Competence

Confidence is about self-perception: of one's abilities and control within the learning context. Learners who believe in their potential success are more likely to exert the effort

required to be successful. Despite the fact that learner expectations are not always realistically aligned with learner abilities, expectations can still positively influence outcomes (Bickford, 1989).

Students with a poor perception of their abilities may become anxious and perform less well than their counterparts with higher confidence in their abilities (Naime-Diefenbach, 1991). Moller (1993) describes learners with high anxiety as often "misdirecting effort from learning to task-irrelevant concerns. Learners high in anxiety are often low in self-esteem and, as such, avoid evaluative situations" (p. 7). In contrast, learners with normal anxiety levels feel more confident and motivated in situations where they must be evaluated.

Perceived Control

When learners believe their efforts and decisions have real consequences, they feel more confident (Bandura, 1977; Keller & Suzuki, 1988). This fosters a higher internal locus of control and a greater sense of self-pride and accomplishment (Moller, 1993). In contrast, learners who believe luck or other uncontrollable outside forces are in charge of their successes or failures tend to feel more helpless and unconfident, and perform at lower levels. Keller (1979) finds that locus of control is more closely related to "attitudes toward performance than to actual performance" (p. 31).

According to Keller and Suzuki (1988), "features in the instruction that promote feelings of personal control over outcomes will help develop confidence and persistence" (p. 405). This is supported by researchers such as Carroll (1963), Bloom (1976), and Kinzie and Sullivan (1989) who recommend allowing learners to control the pace of instruction. However, research is mixed about how much control is actually beneficial to learners (Klein & Keller, 1990). Steinberg (1989) cited numerous studies that showed that learners with little prior knowledge of the subject matter were likely to perform poorly with increased learner control.

Keller (1987a) suggests one strategy for fostering control is to give students knowledge of what is expected of them. However, this is not enough to guarantee confidence: while learners may understand what steps are necessary to complete an assigned task, without the confidence in their ability to successfully complete those tasks, they may not perform as well as they should (Moller, 1993). The concept of control may be particularly relevant to distance learning environments. Roblyer (1999) found that students who chose distance education classes over face-to-face classes often did so out of a greater desire or need for control over their own learning outcomes.

Expectancy for Success

Learners' expectations or beliefs can influence outcomes. For example, if the learner believes he will be successful at a given task, such belief may result in greater effort expended and improve success. Learners with such expectancy for success also possess higher motivation than learners who expect failure (Naime-Diefenbach, 1991).

The learner who expects failure may also evince learned helplessness (Keller, 1979; Seligman, 1975). According to Keller (1979), learned helplessness may be "established by inability, impossibility of the task, or a negative set" (p. 31). Regardless of its origins, once taken hold, learned helplessness can be a powerful impediment to success.

In order to help learners overcome learned helplessness and other self-fulfilling prophecies, it is necessary that instructional designers consider learner anxiety and provide for

instruction that helps boost learner confidence, making them feel competent, in control, and successful. In general, Keller (1987a, 1987b) calls for increasing confidence by providing for success opportunities that are meaningful, provide adequate challenge, bolster achievement, and avoid boredom.

It is important to note that while fear of failure can strongly affect motivation in traditional learning environments, it may be an even greater factor in distance education (Visser, 1998). Even with highly-motivated students, the isolation of the learner, an unfamiliar distance environment, the technology required in distance courses, the distance separating learner and instructor, and other mitigating factors have an effect on learner confidence. Studies have shown that technology brings with it new attitudes and anxiety levels that can have a direct effect on confidence (Yaghi & Ghaith, 2002). The instructor of the distant course must be especially concerned with increasing and maintaining learner confidence.

Method

The purposes of this research were to: (a) determine if there were statistically significant differences in confidence levels of online learners using systematically designed confidence tactics based on Keller's ARCS model; (b) determine if the tactics also produced a statistically significant difference in academic performance; (c) determine if the tactics also produced a statistically significant difference in the remaining ARCS subsections of attention, relevance, and satisfaction; and (d) determine if the tactics also produced a statistically significant difference in overall learner motivation as measured by the total ARCS score.

The design of the instructional materials and treatment in this study was the result of analysis of Keller's work on the ARCS model as well as that of numerous other researchers. After reviewing the literature, tactics that could be applied to improve learner confidence and performance began to emerge. Following Keller's (1999a, b) advice, the confidence-enhancing tactics were designed to be appropriate for the audience, the delivery system and the course, to be in-line with course objectives and assessments, to be integrated with instruction (provide a minimal level of disruption to the learning process), to be cost-effective, and to fit within the time restraints of the class.

Participants

The subjects in this study were undergraduate students enrolled in a for-credit course at a Texas university rated *Carnegie Doctoral/Research Universities—Extensive*. Subjects were selected from participants in a freshman-level computer course and were randomly assigned to either the treatment or the control group.

This study was conducted over a period of approximately five and one-half weeks. The initial sample consisted of 81 (treatment n=41; control n=40) total students and included 37 males (treatment n=18; control n=19) and 44 females (treatment n=23; control n=21). Ages ranged from 18 to 31. Student-reported ethnicities were in-line with university-reported demographics concerning the campus undergraduate population as a whole.

A majority of subjects (67) reported full-time enrollment at the university. For the semester in which this study was conducted, 35 subjects reported this section as their first attempt at an online class, while 44 reported having taken at least one online course in the past.

In addition, 5 subjects rated their experience and proficiency with computers as "beginning user." Fifty-seven students ranked themselves as an "intermediate user." Lastly, 15 rated themselves as an "advanced user" with 2 self-reporting as an "expert user."

Research Design

This study used a true experimental, posttest-only, control-group design, and was undertaken using quantitative methods (Gall, Gall, & Borg, 2003). Two quantitative surveys were used to measure confidence and motivation: (a) the Course Interest Survey (CIS), and (b) the Instructional Materials Motivation Survey (IMMS). These two surveys were delivered in web-based format. Performance was also measured based on the differences between posttest scores automatically generated in *SAM Office 2003*.

This experiment used *SAM Office 2003* and *WebCT* for the delivery and presentation of the tactics, strategies, confidence-enhancing e-mails (CEE), and instructional course content. *SAM* (Skill Assessment Manager) provides training scenarios for *Microsoft Office* in a lifelike, simulated environment designed to replicate *Microsoft Office 2003*. *SAM Office 2003* was chosen as the delivery platform based on the prior experience of the researchers that this platform did an effective job of advancing student skills in *Microsoft Office 2003*. In the case of this study, the students were trained to use the *Access* database program. Three semesters of prior surveys indicated that *Access* was the *Microsoft Office* program students were least familiar with. Therefore, *Access* was chosen to help control for any variance in student ability.

The *SAM* software is widely distributed to universities across the country and claims to have served hundreds of thousands of students and educators since its inception in 1998 (Course Technology Website, 2005). *WebCT*, along with *SAM*, is another widely used distance learning application.

The attention, relevance, and satisfaction components of the ARCS model were not intentionally incorporated into the design of this study in order to better isolate the variable of confidence in question.

Variables

The independent variable (treatment) consisted of ARCS confidence tactics (see Table 1) distributed through *SAM Office 2003* and through confidence-enhancing e-mail messages in the *WebCT* environment (see Figure 1).

The two main dependent variables under investigation were confidence and academic performance. In addition, scores for the remaining ARCS components of attention, relevance, and satisfaction as well as an overall motivation score (ARCS total score) were calculated for comparison purposes.

Table 1

Confidence Tactics (CT)

CT Components	Treatment Group	Control
LR1: Are there clear statements, in terms of observable behaviors, of what is expected of the learners?	Objectives were stated in *SAM* at the beginning of each lesson and restated on guide-sheets. Reminders were stated in the confidence-enhancing e-mails (CEE). In addition, a pretest (see *SO1*) served to familiarize learners with what was expected of them.	Objectives were not stated, and a pretest was not provided.
LR2: Is there a means for learners to write their own goals or objectives?	SAM 2003 is a self-contained simulation environment, so this was not an option.	SAM 2003 is a self-contained simulation environment, so this was not an option.
SO1: Multiple entry points: Provide a pretest and multiple entry points into the instructional material.	The treatment group received a pretest/performance exercise that determined the level of expertise the learner brought to each exercise, and this allowed for the learner to enter the training/instructional material at differing points. Each learner received training/instructional materials only in areas of demonstrated deficiency. Learners were reminded of this in the CEEs.	The control group received no such pretest/performance exercise and was required to take all of the training/instructional material regardless of previous knowledge, experience or expertise.
SO2: Is the content organized in a clear, easy-to-follow sequence?	The content was organized in a pretest-training-posttest sequence. The treatment group received a statement with each lesson assuring them the material was clear and easy-to-follow along with directions highlighting how to proceed through the pretest-training-posttest sequence. Learners were reminded of this in the CEEs.	This group received no such explanation.

(table continues)

Table 1 *(continued)*.

CT Components	Treatment Group	Control
SO3: Are the tasks sequenced from simple to difficult within the material?	Materials in SAM 2003 follow a logical sequence and are generally sequenced from easy to more difficult in each lesson. However, only the treatment group received a statement assuring them of this fact. Learners were reminded of this in the CEEs.	The tasks were sequenced from simple to difficult; however, the control group received no statement.
SO4: Is the overall challenge level appropriate for this audience?	Yes, but only in the treatment group was this stated to the learner. Learners were reminded of this in the CEEs.	Yes, but not stated.
SO5: Are the materials free of "trick" or excessively difficult questions or exercises?	Yes, but only this version stated this fact to the learner, and learners were reminded of this in the CEEs. It should be noted, however, that each student came to the program with differing levels of expertise, so it was impossible to gauge the difficulty level for everyone. To control for this variable, a pretest was made available to the treatment group to assess initial ability and allow for multiple entry points into the instruction. Also, SAM 2003's simulation of Microsoft Access was used for the duration of this experiment, since three past surveys of students have indicated that Access was the program with which they were the least familiar.	Yes, but no pretest was administered, and this fact was not stated.
SO6: Are the exercises consistent with the objectives?	Yes, however, only this version stated the objectives to the learner before beginning. Learners were also reminded of this in the CEEs.	Yes, but objectives were not stated.
SO7: Are there methods for self-evaluation?	Yes, SAM 2003 was set to display simple feedback for each task (e.g., correct or incorrect). Results were also displayed at the end of each exam as a percentage (e.g., 90% correct). Learners were reminded of this in the CEEs.	No feedback was provided, and no results were displayed.

(table continues)

Table 1 *(continued)*.

CT Components	Treatment Group	Control
PC1: Are learners given choices in sequencing? Can they sequence their study of different parts of the material?	All exercises in each module were presented at once, and learners were able to approach the lessons in any order they chose. Learners were reminded of this in the CEEs.	Learners were given the lessons in a particular sequence, one-at-a-time, with a specific due date.
PC2: Are learners allowed to go at their own pace?	Self-pacing was allowed with a due date established clearly up front, and all assignments were opened at the same time and stayed open until the due date with no time-limits for self-pacing. Learners were reminded of this in the CEEs.	Each exercise was timed. The time-limit was decided as follows: (a) examine the time it took for the students in the previous semester to complete exercises, (b) select the longest time for completion, and (c) add thirty minutes. The control group had ample time to complete the exercises but was not informed of this. Every control group subject finished each exercise before time had expired.
PC3: Are learners given opportunities to create their own exercises or methods of demonstrating competency?	Learners were given the opportunity for demonstrating further competency by creating their own exercises (such as an Access database) for extra credit or to take the place of a low test score. Learners were reminded of this in the CEEs.	Learners were given no such opportunity.
PC4: Are learners given choice over study location?	Yes—this was an internet-based class. Learners were reminded of this in the CEEs.	Yes—this was an internet-based class.

(table continues)

Table 1 *(continued)*.

CT Components	Treatment Group	Control
PC5: Are learners given the opportunity to record comments on how the materials could be made more interesting?	A blog and threaded discussion concerning the materials was set up to allow for comments. Learners were encouraged to participate in the CEEs.	There was no access to a blog or threaded discussion about materials.
PC6: Are learners given the opportunity for feedback and practice in a “low risk” environment where it is acceptable to make mistakes and learn from them?	On the pretest, training, and posttest, learners were given feedback regarding performance and were allowed multiple attempts at the posttest. They were reminded about these multiple attempts at the beginning of each exercise and in the CEEs.	The control group received no pretest, one timed attempt at the training with minimal computer-generated feedback, and one attempt at the posttest with no feedback concerning final performance.

Note: Adapted from Moller (1993) and Moller and Russell (1994). LR=Learning Requirements, SO=Success Opportunities, PC=Personal Control, CEE=Confidence-Enhancing Emails.

Dear CECS 1100 Students,

It is my privilege to welcome you to the fall semester of CECS 1100. This letter serves to introduce myself and to offer you some advice and recommendations about the course and the assignments you will be completing for this class. I want you to enjoy and learn from this class, and I have no doubt that you will be successful!

First, let me give you a brief personal introduction. My name is Jason Huett. I have taught this online section of CECS 1100 for two years now. In addition, I have taught numerous different university courses for the last 13 years. I am in the process of completing my PhD in Educational Computing. If you would like to learn more about me, please feel free to access my personal website at http://webpages.charter.net/xxxxxxx/

Second, I would like to offer some suggestions regarding how to proceed with the class.

1. Make sure you have logged in to the correct *SAM Office 2003* section. Your section is _____
2. Make sure you read and follow all the directions on your assignment sheets for each pathway.
3. Remember, *SAM Office 2003* pathways are numbered from one to eight in a clear and easy to follow sequence. While the assignments are available for you to complete in any order, they are generally sequenced from simple to more difficult.
4. Pay attention to due dates. You have one due date for all eight *Access* pathways. Set a schedule for completion of the assignments and stick to it. Please do not procrastinate.
5. Do as well as you can on the pretest but don't worry if you don't know all the answers. Feel free to skip any question you don't know how to do.
6. You can take the posttest up to six times if you desire. I will only count your highest grade.

In these assignments, you have complete control of your pacing, your sequencing, your place of study, and you can have multiple attempts at the graded portion of the pathway. You will be given feedback regarding your performance in terms of a percent grade (e.g. 84% correct) on each exam by *SAM Office 2003*. You can also access your progress report at any time by clicking on the reports button in *SAM Office 2003*.

Lastly, I also encourage you to submit any comments you have concerning these assignments and how they can be improved to the ___section of the discussion board in *WebCT*. I have also set up a blog (short for web-log) where you can record your thoughts, comments, and ideas at http://xxxxx.blogspot.com Give it a try!

Your success in this class depends entirely on you, and you will be successful!

If you ever need my help or have any questions, please do not hesitate to contact me via e-mail at jxxxx@xxxxxxedu. If it is an emergency, I can be reached on my cell at 940-395-3460.

I look forward to working with you this semester.

Sincerely, XXXXX

Comment [jbh1]: Confidence: Assure learners by showing a personal interest in their success.

Comment [jbh2]: Confidence: Expectancy of success.

Comment [jbh3]: Confidence: Personal information to build rapport and lower learner anxiety.

Comment [jbh4]: Confidence: Learning requirements Giving students knowledge of what is expected of them.

Comment [jbh5]: Confidence: Reminder of Success opportunities.

Comment [jbh6]: Confidence: Reminder of Success opportunities

Comment [jbh7]: Confidence: Instill personal control and responsibility by making a study plan.

Comment [jbh8]: Confidence: Lowering learner anxiety.

Comment [jbh9]: Confidence: Reminder of Personal Control.

Comment [jbh10]: Confidence: Reminder of Personal Control

Comment [jbh11]: Confidence: Reminder of Success Opportunities

Comment [jbh12]: Confidence: Reminder of Personal Control

Comment [jbh13]: Confidence: Lowering learner anxiety with reassurance of success and reminder of personal control.

Comment [jbh14]: Confidence: Assure learners by showing a personal interest in their success.

Figure 1. Example of confidence-enhancing email (CEE) with comments.

Instruments

The instruments used in the study were two surveys and series of posttests, and all were delivered in a web-based format at a distance. The *Course Interest Survey* (CIS) was designed to assess the four components of the ARCS model (attention, relevance, confidence, and satisfaction), and to provide an overall motivation score in relation to the class (Keller & Subhiyah, 1993). In this study, an individual measure of learner confidence was highlighted. Prior scores obtained with this instrument have resulted in a Cronbach's alpha for all five components (attention, relevance, confidence, satisfaction and total ARCS score) in excess of .80 (Gabrielle, 2003). For this study, scores on the web-based CIS were found to have a total reliability alpha of .93 based on obtained scores. The reliability alphas for the computed scores of the individual subsections in this study were as follows: attention (.80), relevance (.83), confidence (.80), and satisfaction (.83).

Also created by Keller (1993), the *Instructional Materials Motivation Survey* (IMMS) was used to gauge the motivational effect of instructional materials. In relationship to the instructional material, it was designed to assess the four components of the ARCS model (attention, relevance, confidence, and satisfaction), as well as an overall motivation score. Again, an individual measure of learner confidence was highlighted. Prior scores obtained with this instrument (A, R, C, S, and total ARCS score) have resulted in an overall Cronbach's alpha in excess of .80 (Gabrielle, 2003). The confidence subscale has previously shown a Cronbach's alpha of .90 (Keller, 1993; Moller, 1993). For this study, the web-based IMMS was found to have a total reliability alpha of .93 based on the obtained scores. The reliability alphas for computed scores of the individual subsections in this study were as follows: attention (.86), relevance (.80), confidence (.85), and satisfaction (.86).

Academic performance was measured using posttests automatically generated by *SAM Office 2003* after students completed the training/instructional materials. For this study, the posttest was found to have a total reliability alpha of .86 based on obtained scores.

Results

An independent samples t-test was chosen to compare the survey responses. The treatment group showed statistically significant gains over the control group in terms of learner confidence on the Course Interest Survey (CIS) ($p=.004$) but not the Instructional Materials Motivation Survey (IMMS) ($p=.080$). Again, an independent samples t-test was chosen to compare posttest performance. In this case, the treatment group outperformed the control group on all of the individual posttest measures and, most importantly, on the overall aggregate mean performance score ($p<.001$; $d=1$).

The results showed no statistically significant difference on the attention subsection of the ARCS model between the groups for either the CIS or IMMS using a conservative alpha measure of $p=.01$.

Statistically significant differences were noted for the relevance and satisfaction subscales of the model even though no intentional effort was made to enhance any variable except confidence. There was also a statistically significant difference in overall learner motivation as measured on both the CIS and IMMS.

Confidence and CIS and IMMS Results

Given the design of the study, it does not unreasonable to assume the subjects receiving the confidence-enhancing tactics would perceive an increase in personal confidence and motivation for the class and the instructional materials. This assumption was only partially correct. While the learners in the treatment group did have higher confidence and motivation scores as regards the class (CIS), they did not show similar confidence gains as regards the instructional materials (IMMS). Quantitative results indicated there was a statistically significant difference between the treatment and control groups for confidence as measured by the CIS (p=.004). This finding was further supported by the relatively impressive effect size (*d*=.65) and estimated power (.65) at alpha .01 for the confidence subsection of the CIS.

In addition, results indicated there was not a statistically significant difference between the treatment and control groups for confidence as measured by the IMMS (p=.080). However, the reported effect size (*d*=.41) and estimated power (.27) at alpha .01 cannot be dismissed as insignificant. Further study is warranted before a definitive conclusion can be drawn. The means, standard deviations, skewness and kurtosis values, effect size, and approximate power for the confidence variable for both measures is reported in Table 2.

Table 2

Results for the Confidence Subsection of the CIS and IMMS

Subsection	Section	N	Mean	Std. Dev	Skewness	Kurtosis	p	Effect Size (*d*)	Approx. Power (p=.05)	Approx. Power (p=.01)
CIS Confidence	Treatment	38	34.79	4.916	-1.010	.583	.004	.65	.87	.65
	Control	37	31.46	4.857	-1.269	.759				
	Total	75	33.15	5.135	-.928	.863				
IMMS Confidence	Treatment	35	31.77	7.276	-.607	-.207	.080	.41	.53	.27
	Control	37	28.70	7.356	-.159	-.641				
	Total	72	30.19	7.428	-.348	-.619				

Performance Results

Differences in academic performance were measured between the control group and the treatment group using automatically generated test scores in *SAM Office 2003*. There were eight posttest subsections delivered over the treatment period. The results examined each of these posttest subsections individually and then as an aggregate mean score for those completing all eight tests. Only those completing all eight exams were included in the aggregate mean score. The overall average showed a statistically significant difference in performance between the treatment and control groups ($p<.001$).

Worthy of note was the effect size of *1* for the average mean score. This can be interpreted to mean that the treatment group (n=30), on average, scored approximately one standard deviation above the average mean of the control group (n=26). Another way of looking at this would be to say that the mean of the treatment group was at approximately the 84th percentile of the control group. Though Cohen (1988) does caution against applying his guideline too rigidly, this most likely can be interpreted as a large effect size with substantial power (.91). This supports the contention that the students in the treatment group, on average, outperformed the control group on the posttest measures.

Attention, Relevance, Satisfaction and Overall Motivation

Regarding attention, at alpha .01 ($p\leq.01$) there was no statistically significant difference ($p=.014$) between the control (n=37) and treatment (n=38) groups for the attention subscale on the CIS. In addition, there was no statistically significant difference ($p=.015$) between the control (n=37) and treatment (n=35) groups for the attention subscale on the IMMS survey measure. However, the medium effect sizes (CIS d=.56; IMMS d=.57), moderate power ratings (CIS=.49; IMMS =.48), and the relative consistency of findings across the other subsections warrant further study (perhaps with larger sample sizes) before a definitive conclusion can be drawn about the statistical and practical implications of the applied treatment on the participants' levels of attention.

Regarding relevance, at alpha .01 ($p\leq.01$), *unexpectedly*, there was a statistically significant difference ($p<.001$) between the control (n=37) and treatment (n=38) groups for the relevance subscale on the CIS. In addition, there was a statistically significant difference ($p=.001$) between the control (n=37) and treatment (n=35) groups on the IMMS survey measure. The impressive effect sizes (CIS d=.85; IMMS d=.75) and considerable power ratings (CIS=.88; IMMS =.80) lend credence to the claim that the treatment produced unintended effects on the participants' perception of relevance for both the course (CIS) and the instructional materials (IMMS).

Regarding satisfaction, *unexpectedly*, there was a statistically significant difference ($p=.001$) between the control (n=37) and treatment (n=38) groups for the satisfaction subscale on the CIS. In addition, there was a statistically significant difference ($p=.002$) between the control (n=37) and treatment (n=35) groups on the IMMS survey measure. Similar to relevance, the impressive effect sizes (CIS d=.78; IMMS d=.72) and considerable power ratings (CIS=.83; IMMS =.73) lend credence to the claim that the treatment produced unintended effects on the participants' perception of satisfaction for both the course (CIS) and the instructional materials (IMMS).

Discussion

Based on the study's design, one could potentially expect the results to reflect an increase in learner confidence on both the IMMS and CIS measures. In fact, given that many of the confidence tactics used in this study were specifically designed to enhance the instructional materials, one would expect the IMMS to show a noticeable increase in learner confidence even if the CIS did not. However, quite the opposite was the case: the students in the treatment group found the tactics confidence-enhancing as regards the class as a whole but not the instructional materials. In a similar study, Moller (1993) failed to obtain changes in confidence as regards instructional materials and listed three possible explanations:

> 1) The ARCS model is insufficient for improving learner confidence; 2) the resulting tactics and methods used in the research were inappropriate for these subjects or implemented improperly; and 3) the differences were too small to measure using the selected empirical research methods. (p. 89)

To this and echoing Babe (1995), the researchers would add: 4) perhaps the role of the confidence variable, as one of the four main subsections of motivation, needs to be reexamined.

Taking each of these possible explanations in turn, there is insufficient data to suggest that the ARCS model is somehow flawed or incomplete when it comes to addressing learner confidence. The model has shown an ability to increase learner confidence even when confidence was not the focus of the researchers' investigations. The fact that the model, as a whole, can produce increases in confidence is not really in question. The question is more whether the individual subsection of confidence can be targeted as a valid, independent construct that produces consistent results.

Along with other research, this study's rather mixed results suggest that confidence may indeed be a more abstract and complicated dimension in the overall realm of motivation than the ARCS model would lead one to believe. Researchers who have specifically targeted confidence for enhancement have been unable to validate the independence nature of the confidence component under controlled conditions (Moller, 1993; Naime-Diefenbach, 1991). As mentioned earlier, researchers such as Gabrielle (2003) and Babe (1995) found mixed returns for confidence even when confidence was not the focus of the study.

Given the complexity of isolating confidence and of dealing with the cognitive and affective domains of the individual as well as concepts such as anxiety, locus of control, and fear of failure, it appears one weakness of the ARCS model may be its oversimplification of the abstract and highly complex concept of confidence. In order to obtain an increase in confidence, it may be necessary to take a more comprehensive approach to motivating students and include enhancements to the other ARCS components even if the desire is to focus on confidence alone. This is supported by researchers such as Marovitz and Buckley (1987), who felt the results of their experiments indicated "that the four factors of Keller's ARCS model are intricately bound together" (p.12). This would require a rethinking of the ARCS model as a series of related and not independent constructs for improving motivation (Babe, 1995).

The second possible explanation for the lack of a statistically significant difference in confidence regarding the instructional materials is that the confidence tactics and confidence-enhancing e-mails used in this study were ineffective or implemented improperly. This is always a possibility. A few strategies that may have had an effect on confidence were "built-in" to the

SAM Office 2003 software (such as any novelty effects generated through the simulation program or student choice over study location) and could not be removed. This may have impacted the confidence levels of participants in unforeseeable ways. In addition, treatment group subjects indicated that they found some of the confidence tactics used in this study more effective than others.

For example, informal surveys of participants indicated they found the guide-sheets for each *Access* assignment and the e-mail messages, which incorporated all of the tactics (see Table 1) under *Component I: Learning Requirements* and most of those under *Component II: Success Opportunities*, as confidence-boosting. However, only two students took advantage of the opportunity, under *Component III: Personal Control*, to create their own exercises or methods of demonstrating competency. Also, under the same component of personal control, only two students accessed the blog and threaded discussion on how to make the materials more interesting. Finally, even though students were given a choice to control their own sequencing, almost all chose to complete the assignments in the same order.

Researchers have linked increases in learner control to increases in confidence (and positive attitudes of learners) as well as decreases in learner anxiety (Bandura, 1977; Keller & Suzuki, 1988; Kinzie, 1990; Kinzie & Sullivan, 1989; Moller & Russell, 1994). However, in this study, some members of the control group indicated an appreciation for the strict structure, deadlines and pacing. A majority of treatment group students (64%), who were given personal control to complete the assignments at any time during a five-and-one-half-week window, waited until the last 72 hours to "cram in" most of the assignments before they were due. Only 24% of the treatment group finished the required assignments before the last week. This is not altogether surprising since, according to Ferrari, Keane, Wolfe, and Beck (1998), "as many as 70% of American college students engage in frequent academic procrastination" (p. 199).

There is no real way of knowing how such procrastination affected the confidence levels of the treatment group, but one can imagine that procrastination brings with it an increase in learner anxiety. Anxiety has an inverse relationship to confidence, so the effect on confidence levels was probably not a positive one. Wolters (2003) cited more than a dozen studies linking procrastination to higher levels of anxiety and lower levels of self-esteem. Milgram, Marshevsky, and Sadeh (1995) found that students with fewer abilities to manage their own learning requirements tended to procrastinate more when given a choice over when to begin their own tasks. This could account for the lack of difference in confidence as measured on the IMMS. If students are waiting to the last minute to complete the materials, the treatment does not have very long to take effect.

One may need to reexamine certain aspects of personal control (including the tactics used in this study) to determine if they are indeed confidence-enhancing for subjects similar to those in this experiment. One may also want to examine in more detail how personal control issues affect distance learning environments in particular. What seems clear is that the students in this study did not use some of the tactics as intended. In fact, some of the tactics used in this study (mostly those under *Personal Control*) may have had the opposite effect of what was intended. Even Keller admits that allowing learners "to control the instructional strategy of a lesson may not be beneficial" (Klein and Keller, 1990, p. 145). Such findings further the idea that trying to isolate confidence when dealing with diverse groups of individuals, with differing levels of maturity, may be a more difficult process than first envisioned.

Third, another way of stating differences may be too small to measure is to say perhaps the IMMS survey is not sensitive enough to detect short-term changes. While no current research indicates that the IMMS survey is a poor or weak measure of learner confidence, it seems possible that this survey may not be sensitive enough to detect short-term changes. Perhaps the confidence enhancements are producing a desired effect, but the survey cannot consistently detect the changes over the short-term. Given the protean motivational nature of learners over time, the survey would need to be highly sensitive and/or delivered at precisely the right time to accurately reflect learner changes in confidence in the short-term. Over a brief period, learners may not even be aware enough of a change to report it accurately.

The question of study duration brings up other issues. Moller (1993) writes "assuming the longer an attitude is held the stronger it becomes, it may be unrealistic to assume that a measurable change [in confidence] can be detected using a short-term experimental design" (p. 92). The meaning of "short-term" is unclear. A wider review of the literature does little to clarify exactly how much time it takes for the ARCS model effect a statistically significant difference in learner confidence.

Looking at previous studies, one finds a diverse spectrum of study durations resulting in different assessments of subjects' confidence on the IMMS. For example, Moller (1993) and Naime-Diefenbach (1991) studied confidence using written instructional materials in one short, self-instructional lesson and showed no noticeable changes in confidence as measured on the IMMS. Babe (1995) used a longer instructional lesson with relevance-enhancing strategies and showed an increase in learner confidence on IMMS. This study used a five-and-one-half-week treatment period with no confidence changes on the IMMS but notable changes on the CIS. Gabrielle (2003) applied her treatments to a highly homogenous group of military cadets over one long semester and showed increases in confidence on the IMMS but not the CIS. In short, there is no clear picture of how much time is necessary to identify noticeable confidence changes for either the instructional materials or the class as a whole.

Lastly, there is the idea that the confidence subsection should be reexamined as one of the four main constructs of the ARCS model of motivation. With such issues as maturity, anxiety, locus of control, and fear of failure, confidence may not lend itself to easy encapsulation inside of a model. There is no doubt that confidence is a part of motivation, but the ARCS model implies that there are specific strategies and variables related only to confidence. These strategies for improving confidence are independent of the other ARCS components and, hence, can be individually targeted and manipulated (Keller, 1987a).

Naime-Diefenbach (1991) claimed to have validated the independent attention component of the ARCS model. Babe (1995), Nwagbara (1993), and Chang (2001) validated the usefulness of targeting the relevance component, but Babe questioned its independent nature. The researchers could locate no studies specifically targeting the satisfaction component, but one can speculate that targeting instruction for increases in student satisfaction would not possess the same degree of complexity as enhancing learner confidence.

To the researchers' knowledge, all studies to date, including this one, that have used the ARCS model to specifically target confidence have failed to achieve statistically significant results as reported by the IMMS. Possibly, placing the more abstract and difficult dimension of confidence on equal footing with the other components of the model diminishes the conceptual validity of the model.

Performance

The data showed that the students in the treatment group, on average, outperformed the control group on the posttest measures. This is in-line with previous research findings that suggest increases in motivation can translate into increases in performance or achievement (Bickford, 1989; Gabrielle, 2003; Song & Keller, 2001).

Since the treatment group was exposed to a pretest exercise as a confidence tactic, some of the difference in scores may have been attributable to a "practice effect." However, it is the researchers' contention that this effect would not account for all the variance in scores.

A, R, S and Overall Motivation

For this study, there were clear differences noted for relevance, satisfaction and overall motivation. By way of comparison to other studies, Moller (1993) showed no changes in any of the ARCS subsections using the IMMS. Targeting overall motivation, Gabrielle (2003) found statistically significant differences only for attention with a moderate difference for satisfaction ($p=.076$) and no difference on the relevance and confidence subsections of the CIS. Regarding the IMMS, she found statistically significant differences on all subsections. In a study that specifically manipulated the attention and confidence subsections, Naime-Diefenbach (1991) showed a statistically significant increase in attention but no increases in confidence or the remaining ARCS subsections of the IMMS. As one can see, consistency of findings is an issue across studies.

One particular reason for the mixed findings in this study may be an overlap of the confidence tactics (see Table 1) and confidence-enhancing e-mails (see Figure 1) into the attention, relevance and satisfaction components. For instance, providing the treatment group the opportunity to create their own exercises or methods of demonstrating competency (PC3) and allowing the treatment group access to a blog and threaded discussion for comments (PC5) may have enhanced attention or even relevance. Tactics such as these might stimulate the learner's curiosity to think of ideas for improvement that increase feelings of "connectedness," or relevance, to the material. Allowing learners multiple entry points into the instruction (SO1), which catered to individual skills and avoided wasting time, might have increased the learner's sense of satisfaction as well as confidence.

Although the confidence-enhancing e-mails used in this study were designed to stress only the confidence tactics and strategies, it is possible that they had an indirect effect on the treatment group's sense of attention, relevance, and satisfaction. Simply receiving the e-mails might serve to gain learner attention. The concern, verbal praise, and goal reminders expressed in the messages may have served to increase learner satisfaction and improved their sense of connectedness (relevance) to the subject matter. Also, *SAM Office 2003* is a simulation program, and simulations and real-world settings are suggested by Keller for enhancing both satisfaction and relevance (Babe, 1995). However, this study's findings still call into question the discriminate validity of the separate categories of the ARCS model. At the very least, this study highlights the challenges faced in isolating confidence for independent enhancement.

Perhaps the most important finding is that overall motivation can be enhanced in learners through the application of external factors. That was the belief which initially guided this study and, despite any disagreement about the validity of the independent components of the ARCS model, the model, as a whole, proves to be an effective design tool for increasing overall learner

motivation. The findings of this study confirm decades of previous research that motivation is a critical component to learning (Keller, 1979, 1987a, 1987b, 1987c; Means, Jonassen & Dwyer, 1997; Song & Keller, 2001). This study also furthers the body of research by affirming the ARCS model as a viable model for increasing motivation and performance in distance education settings.

Implications for Instructional Design

The results of this study offer several suggestions for future researchers and instructional designers. First, overall motivation can be enhanced in distance learners through the application of carefully crafted external factors such as confidence tactics and confidence-enhancing e-mails. Second, the performance results of this study show that motivation is a powerful force in learning. This study confirms that systematically designed and carefully applied tactics can improve performance. Third, Keller's ARCS model is an effective design tool for building motivational enhancements and e-mails into distance education environments, and one should not shy away from using Keller's ARCS model as a conceptual framework for new and emerging technologies. If one believes that distance learning environments pose greater challenges to learner motivation than their face-to-face counterparts, then a well-thought-out systematic approach to manipulating distance learner motivation is an important design consideration.

While the study did not support the discriminate validity of the separate category of confidence, it does provide future designers with material proven useful for increasing overall motivation and performance. One implication future designers may wish to take from this study is to focus less on individual aspects of the ARCS model and more on a learner's overall sense of motivation. To this end, confidence is a powerful variable that needs to be included in instructional design.

Further Research

The results of this study have spawned several ongoing research projects. Many of the confidence-enhancing tactics used in this study were delivered through e-mail. This has led to follow-up studies focusing on motivational messages similar to the one illustrated in Figure 1.

Following the work of researchers who found positive outcomes in learner motivation and/or retention using motivational messages (Gabrielle, 2003; Huett, 2006; J. Visser, 1990; Visser and Keller, 1990; Visser, Plomp, and Kuiper, 1999; 2002), the ARCS model is being used as a guide for developing motivational communications with distance education students. In one ongoing study conducted by the authors, the initial results look promising. Though data analysis is still underway, in two large distance education computer classes (where the only difference is the presence of ARCS-based motivational e-mail messages delivered at roughly 10-day intervals for the treatment), preliminary results show significant increases in student motivation, satisfaction, relevance, and attention. Similar to this study, no significant differences have been noted for confidence. Also, the treatment group shows a 6.35% failure rate compared to that of 19% for the control. In addition, the treatment group has an average drop-out (non-completer) rate of 4.76% compared to 15.5% for the control.

Other studies using similar messages are currently in the early stages of replication with distant students, from undergraduates to graduate, in online classes dealing with a variety of subject matters. It seems feasible that the social aspect or sense of community created through

motivational communications may be part of the necessary support structure distance learners need (Cathcart, Samovar, & Henman, 1996; Kember, Lai, Murphy, Shaw & Yuen, 1994; Moller, 1998).

While additional research is needed to validate the effects of these motivational communications, ongoing research suggests that efforts to improve motivational communications in distance learning situations could have significant returns.

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The Design and Impact of Using an Advance Organizer-Guided Behavior Matrix to Support Teachers' Just-in-Time Problem Solving – A Developmental Research Study

Wei-Chen Hung
James Lockard
Northern Illinois University

Abstract

This study adopted developmental research methodology to systematically investigate the process of applying instructional design, human-computer interaction, and software engineering principles to a Performance Support System (PSS). To facilitate this investigation, Ausubel's advance organizer theoretical approach was used to integrate the instructional design principles into the PSS; a grid interface with matrix-based design metaphor was incorporated to facilitate human-computer interaction between users and the PSS; and participatory rapid prototyping was utilized to engineer the PSS. Developmental data were collected from a six-stage participatory rapid prototyping process. Findings suggest that the proposed advance organizer concept combined with the matrix design metaphor has the potential to foster participants' metacognitive awareness in the selection of possible problem solutions and to enhance participants' searches for relevant content information.

Introduction

Developmental research, "the systematic study of designing, developing and evaluating instructional programs, processes, and products that must meet the criteria of internal consistency and effectiveness" (Richey, 1994, p. 714), is one of the research methods used in instructional development where the information produced by the research is mainly a resource to inform instructional designers of how particular problems have been resolved. By conducting developmental research, instructional researchers are able to explore and document the instructional procedures used by the developers – how they identify admissible alternatives and then proceed to make decisions about the most satisfactory among them. Sanders (1981) first used the term "developmental research," proposing it as a better way to understand the instructional process than were conventional laboratory-based approaches. Whereas laboratory-based research attempts to describe a phenomenon through a well-controlled experimental setting, and naturalistic research attempts to generalize from a phenomenon, developmental research is a process "directed at determining whether, through particular interventions, desirable results can be achieved, and if so, under what conditions" (Sanders, 1981, p.11). By "interventions," Sanders means the process of continual refinement by which a developer improves a system with feedback from its users. The advantage of developmental research is that it is "applicable to those creative, indeterminate processes that are intractable through conventional means" (Sanders, 1981, p.12).

There are several good reasons for using developmental research to understand instructional development and other education-related processes. Perhaps the main purpose of developmental research is "the invention and improvement of creative approaches to enhancing human communication, learning, and performance through the use of technology and theory" (Reeves, 1996, p. 462). Many researchers have proposed or conducted developmental research during the creation of instructional programs and learning environments to advance the practice of instructional development (Clark, 1989; Terlouw, 1993; Reeves, 1996; Reigeluth & Frick, 1999; van den Akker, 1999; Richey, Klein, & Nelson, 2004). *Studying*, *describing*, *analyzing*, and *reporting* the design and development process of an innovative instructional program or product help us to better understand how theoretical frameworks (e.g., learning theories and instructional principles) are applied to that process and how we should revise both the program and its design framework.

The present study sought to investigate the issues involved in the development of a Performance Support System (PSS) designed for classroom behavior management by teachers. The goal was to understand how instructional design principles, human-computer interaction, and software engineering can be applied to the design and development processes to create an "instructionally integrated" PSS. With this integrative approach, this study examines how the proposed design framework and development process can (a) transform the PSS technology into an instructionally integrated approach..

The Inherent Problems of Technically-Driven PSSs

Although the design framework of a performance support system (PSS) has not been clearly defined in the extant literature, the major technical characteristic of such systems has been identified as a module-based approach which allows for flexibility in the exchange of modules to meet users' needs and provides the possibility of parallel development for each functional component (Barker & Banerji, 1995; Gery et al., 2000; Raybould, 1995; Tjahjono & Greenough, 2002; van Schaik et al., 2002). Based on this technical characteristic, a PSS offers designers a way to integrate multiple instructional modules (such as a tutorial, hypertext, advisory systems, information management systems, and collaboration tools) into a package with a common interface that provides users with a helpful system for dealing with various tasks and problems encountered in their work environment. However, such a generic design approach is potentially problematic because it relies completely on technology to "glue" all the modules into one unit with an interface as the wrap.

By integrating the modules through a common interface, the PSS is merely "technically integrated," but not "instructionally integrated." That is, each module is linked and connected by the interface alone. Such an interface, if appropriately designed, may help users navigate among modules with ease (e.g., via effective arrangement of screen elements) and provide improved orientation to the system's technical structure (e.g., through uniformity & consistent screen layouts), yet it may not be enough to support content comprehension and problem solving activities that are inherent in the learning and performance goals of a PSS. This is because users are still working with separate system components without additional guidance or scaffolding to lead them to other relevant modules. Therefore, in order to support content and learning activities, an effective PSS interface should incorporate instructional attributes (e.g., concept maps, advance organizers) to help users anchor their knowledge and skills acquisitions in meaningful contexts.

In addition, because traditionally each PSS module is functionally independent, the process could result in a "shotgun" style design; the designer hopes that at least one of the many modules will be usable in order for the whole system to be useful. This is a passive design approach that does not provide structures and relationships among components to allow users to take full advantage of the activities and support contained in each component. Such a design is also heavily technology-driven, and designers (and developers) ultimately may be preoccupied with technical problems, rather than with supporting users. Therefore, to overcome the problems caused by a generic, technology-oriented approach, a PSS design should begin with the integration of an instructional design framework to increase its pedagogical usability. This approach can also help organize, structure, and evaluate relevant technical components for on-the-job task learning and performance gains.

Proposed Design Frameworks

In order to design a PSS that is integrative (rather than "shotgun" oriented), performance-centered, and instructionally purposive, the present study incorporated features of instructional design principles, human computer interaction, and software engineering to guide the selection and integration of system modules. In this study, we proposed three design strategies to achieve this integrated framework: (a) advance organizer-based instructional design principles for scaffolding, (b) a matrix metaphor to support and guide users' content retrieval and access to PSS modules, and (c) a grid-based interface design to integrate the PSS modules. The relationships among the integration strategies, theoretical support, and design procedures used in this study are outlined in Table 1. These three design strategies were then operationalized through a participatory rapid prototyping development process.

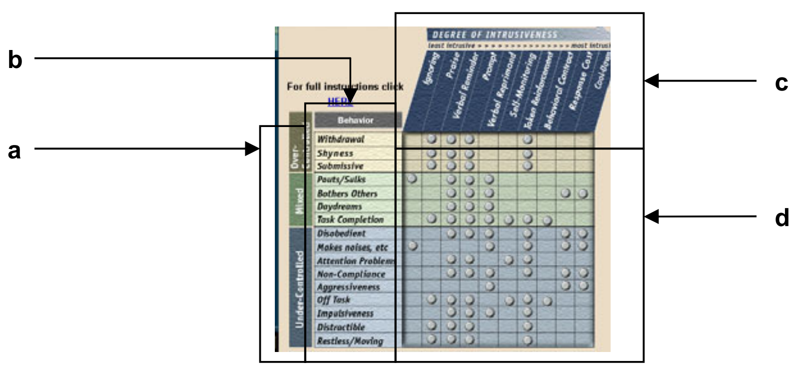
Table 1: Proposed Design Strategies

Integration strategies	Purpose (Theoretical Support)	Method (Design Procedures)
Scaffold users' content comprehension and problem analysis through advance organizers	1) Guide the selection of PSS modules (together with the matrix design strategy) 2) Meet expert/user expectations 3) Raise users' cognitive awareness of the unfamiliar domain knowledge that will be learned/performed	1) Begin with a comparative organizer to provide ideational scaffolding for the content materials to be learned. 2) Add expository organizer to provide inclusive information based on the information residing in the comparative organizer. 3) Incorporate expert/empirical based strategies and actions to operationalize information learned from both organizers.
Guide and lead users' content retrieval and access to PSS modules through a matrix	1) Guide the selection of PSS modules (together with the advance organizer design strategy) 2) Transform the conceptual framework of expository and	1) Use a single screen interaction approach to improve comprehension of content presentation and avoid disconnecting of content relevance and navigation loss (Hammond, 1993). 2) Structure information in three ways to

metaphor	comparative organizers into a work panel for problem identification 3) Provide visual overview of content materials to remind and give hints to learners about subsequent tasks to be performed	increase the learning materials' application and context relevance. 3) Use hypertext technology to give users access to more information on that core content as necessary for comprehension.
Visually unite the selected PSS modules with a grid-based interface	1) Create an identical interface that would unite system modules to ensure consistency in their looks and feels 2) Minimize the extent to which users need to be aware of what they are doing. 3) Increase users' knowledge of how to use available functions, rather than increasing their knowledge about some specific aspect of the structure of these functions	1) Develop a set of shared elements (e.g., print, bookmark, note taking, glossary) to maintain consistency in the interface's navigation structure and orientation 2) Employ a grid design technique along with the "golden ratio" aesthetic principle to proportion the navigation structure and content layout. 3) Divide the entire window into blocks of equal size and then start to assign a certain number of blocks to each area.

Our goal for applying an advance organizer to the system interface was to make the overall content information readily available to the users. This would allow users to mentally construct an exploration and comparison process and facilitate development of the skills required for problem solving. To accomplish this, we created a multi-dimensional matrix structure that was combined with a functional and visual design metaphor to graphically lay out the planned instructional strategies on the system work areas. *Graphically laid out* means that the instructional design strategies (i.e., expository and comparative) were transformed into four visual areas. Specifically, these are areas for (a) comparing teachers' existing knowledge with new knowledge; (b) exploring inclusive information about the new knowledge; (c) exploring applications (i.e., interventions) of inclusive information; and (d) application strategies for the inclusive information. These four visual areas were then integrated and sequenced into the multi-dimensional matrix structure. Within this matrix structure, presentation of the inclusive information of the content materials is represented in a single page (or single computer screen) to provide teachers with a holistic view of the content materials as well as their inter-relationships, thereby providing a potentially meaningful learning environment. Figure 1 shows how these four visual areas are integrated and sequenced in the multi-dimensional matrix structure to create the Behavior Matrix module.

Figure 1: Screen shot of the matrix-based behavior information organizer



System Developmental Research

The purpose of the present study was to examine how teachers perceive, react, and use the above-described design strategies in an actual work setting during the system development process. In this sense, the study was developmental research intended to systematically explore the consistency and effectiveness of an instructional product's design, development, and evaluation process (Richey, 1994). From the study of this systematic process, we sought to gain a detailed understanding of how the design affects users, as well as issues that arose during the development process. The following developmental research questions were examined in this study:

1. How are design strategies realized and what issues are encountered in the development process? This research question was adopted to guide our research in the design and development processes.

2. How do the design strategies (advance organizer, matrix structure, grid-based interface) affect the teachers' development of intervention strategies? This research question was adopted to guide our research in the evaluation process.

Project Participants

Thirteen participants from a private foundation's existing 28-member focus group were recruited after they indicated a willingness to participate in this study. All participants were either elementary or junior-high school teachers from three school districts in the suburban Chicago area and most of them had more than ten years of teaching experience. Among the thirteen participants, three were resource teachers and ten were special education teachers. Participants were asked to complete a ten-month, six-stage system development evaluation process, including assessment, design, prototyping, planning, action, and audit.

In addition to the thirteen participants, two university professors from instructional development and special education respectively, a pediatric doctor who specialized in attention-deficit disorder and prenatal drug-exposure, a retired special education teacher, a clinical psychologist, and a software engineer who specialized in relational database development also participated as subject matter experts (SMEs) in expert appraisals during the development of the system design. Additionally, a project design and development team of five persons was formed, consisting of three content experts, one educational software developer (who also was the primary researcher), and one media developer.

Research Methods

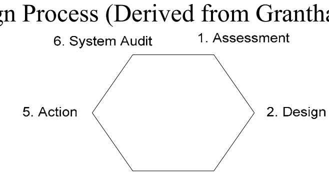
A mixed methodology was used in this study to address the complexity of the development process. Each development stage adopted different data collection methods to meet its unique needs. These data collection methods included focus groups, expert appraisal, usability evaluation, user interviews, impact survey, and a case study. Data collection instruments included a user profile questionnaire, system appraisal checklist, evaluation tasks for usability testing, a field interview guide, and an impact questionnaire. Detailed descriptions of each data collection method and instrument are organized according to the development stages and presented in the findings section.

Research Procedure: System Development Approach

To apply the three design strategies in actual development, we adopted a rapid prototyping process (e.g., Jones and Richey, 2000; Tripp and Bichelmeyer, 1990) to develop the PSS system prototype. Rapid prototyping is a method commonly used in software engineering. Its purpose is to bring project sponsors, users, content experts, and a development team together to discover effective solutions to dynamic problems through a seamless iterative process of designing, constructing, and evaluating prototypes (Pressman, 1992). When developing the system prototype, rather than minimizing the task by merely developing a *mock-up* version of the system, we attempted to explore any possible tasks involved in an actual setting by engaging in a *small-scale* version of the design and development process. Thus, the prototyping could be applied within a short cycle of time to portray the characteristics of the full-scale version (Tripp & Bichelmeyer, 1990).

A common shortcoming of previous studies using rapid prototyping has been the lack of specific steps, rules, and guidelines (Dey, Abowd, & Salber, 2001; Lohr, et al., 2001; Nixon & Lee, 2001). To address this potential shortcoming, we added a systematic approach, the *participatory design process* model developed by Grantham and Nichols (1993), as shown in Figure 2, to help us operationalize the system development, data collection, and evaluation in a continuous process. In this looping design approach, the key to success involves following the sequence in order (1-2-3-4-5-6) and repeating the process (without omitting any steps), until the desired results are achieved. Users need to be continuously involved throughout the design cycle. By applying participatory design techniques within the rapid prototyping process, we sought to maintain the development process in a structured, consistent, and systematic manner.

Figure 2. Six-Stage Participatory Design Process (Derived from Grantham & Nichols, 1992)



Findings and implications of the system development process

In this section, data collected from each stage are reported and our reflections about the development process are also described to better illustrate the nature of real-world instructional system development.

Stage 1: Assessment. The purpose of this stage was to assess; (a) how teachers develop intervention strategies for classroom behavior management; (b) what skills and knowledge need to be acquired to become a proficient problem-solver when dealing with classroom management issues; and (c) how PSS functionality could be incorporated to support learning and on-task performance. Results of this analysis were used to help us execute both design strategies (development of a matrix-based advance organizer and selection of appropriate PSS modules). Teacher focus group interviews were conducted to solicit information on what system modules can and should be incorporated to the present system. Prior to the teacher focus group, a user profile survey was administered to gather data concerning each participant's computer usage and experience with classroom behavior management. Findings from the survey helped the project team plan the focus group interviews and generate a list of system functions that could be incorporated to the system.

Data from the profile survey indicated that the mean teaching experience of the participants was ten years, and they all received at least two training workshops for classroom technology integration. Participants also reported that they spent, on average 2-3 hours daily on the computer engaging in the three most common activities: (1) word processing, (2) Internet searches for teaching resources, and (3) email activity. Furthermore, when asked about their experience with classroom behavior management, most participants reported that they rely on their teaching experience and information given by the school resources teachers and students' parents to develop interventions for classroom behavior management. They seldom relied on computer (e.g., searching the Internet for relevant resources) and book references to assist in their development of classroom intervention strategies. It was evident that the participants were expected to act independently to resolve their daily classroom behavior issues.

Participants' experiences with classroom behavior management was further addressed in the focus group interviews to determine how the proposed system could further support teachers' individual performance in resolving their daily classroom behavior issues. Information obtained from these focus groups suggested that this phenomena was three-fold. First, the problems that participants encountered often required immediate attention. Second, the participants were accustomed to solving these problems on their own or with parents of the students, unless the problems were beyond their capability, in which case they would turn to the resource teachers. Third, the availability of resource teachers, the lack of explicit guidelines about classroom behavior management, and the large number of students in the classroom encouraged the participants to plan their own interventions without asking for help.

Participants also indicated that a mechanism for managing their development of intervention strategies and keeping track of the implemented interventions would in fact help them document their efforts in classroom management and enhance their ability to deliver better instruction in the classroom. Such mechanism would particularly help participants when completing an Individual Education Plan (IEP) which requires special education teachers to keep track of individual student's progress.

From these findings, it was confirmed that a system that focused on individual performance and just-in-time support was needed. As a result, when the participants were asked to choose a list of twelve possible system modules that they would like to have incorporated into the performance support system, the majority agreed that a feature-rich content knowledge base would be most beneficial to them in finding relevant and usable information for their development of intervention strategies. Next, a system module for them to apply? the knowledge that they have acquired and a system module for collaboration opportunity among resources teachers and parents were also favored by the majority of participants. It is important to note that participants had mixed feelings about a record keeper type of system module. Participants thought that the record keeper was an important function to be included in the future PSS because it would help them to organize and record the intervention strategies that they use with students. However, other participants questioned the usefulness of this module in the field because they already have data bases to perform similar functions and thus may not want to adopt a new one. Furthermore, participants pointed out that some of the school districts use standard data bases to record students' performance and behavior. These data bases are typically considered to be school property and cannot be replaced or transferred. Finally, the discussion centered on how information management should be redesigned so that it would be more suitable for teachers in general.

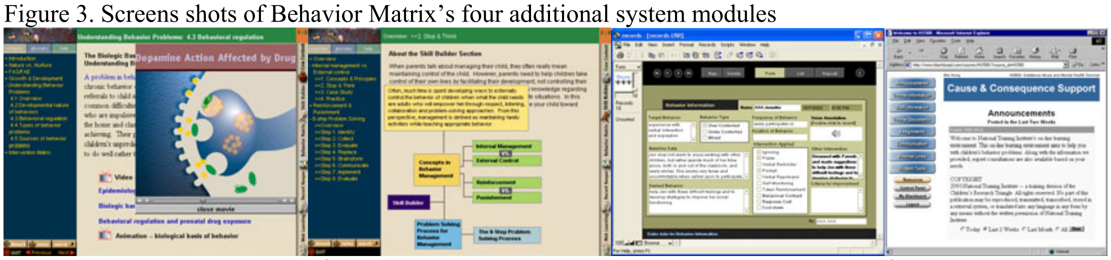
In response to this feedback, the project team structured the system design framework around the support of individual performance needs – by providing a set of performance and reference tools that could help the participants address their immediate needs, while also offering opportunities for knowledge advancement. In addition, communication features were planned so that users would have a collaboration function that facilitated participation in a discussion group or facilitator-monitored collaborative learning. As a result, four additional system modules (in addition to the behavior matrix) were selected and adopted. The selection of the four modules was determined by: (1) how acceptable the system modules would be to the participants; and (2) how the system modules could be incorporated to support general problem solving approaches used in the field of clinical psychology.

Stage 2: Design. After the selection of system modules was made, a fully interactive storyboard of the system interface and navigation structure was created based on the proposed matrix metaphor and grid based interface. The goal was to represent the visible contents of each screen (e.g., graphic, text, title, video) and system interactivity (e.g., behavior matrix interaction) that would be encountered by the users. Microsoft PowerPoint was used to assemble the content and flow of every screen the users could encounter. This storyboard was then reviewed by the panel of subject matter experts (SME). The six SMEs were invited to participate in two Delphi sessions of expert appraisal to elicit their opinions on the design structure and system module integration. The Delphi sessions followed the procedures suggested by Vennix and Gubbels (1994). The first Delphi session was conducted as a one-on-one appraisal session to elicit each SME's opinions and understanding of the design structure and system module integration. The second Delphi session included all six SMEs, who participated in a two-hour group discussion to ascertain the practicality and versatility of the design structure and system modules.

In the first Delphi session, after the presentation of the storyboard, a system appraisal checklist was distributed to each SME. The list contained 75 yes/no questions that were divided into three main constructs: instructional features, interface & orientation, and technical accuracy. Data gathered from the individual checklist were collected and summarized. Twelve items were identified that reflected less than 90% consensus (i.e., fewer than 5 out of 6 SMEs checked the same answer). These items included five items from the instructional features construct concerning module and topical sequence, navigational depth of behavior management content and user data record coverage; four items from the interface & orientation construct regarding icon appearance, size of control, and reversal of undesirable action; and three items from the technical accuracy -construct regarding feedback of task completion and labeling. These 12 items were redistributed in a second Delphi session for group discussion and to elicit suggestions for improvement.

Before administering the second Delphi session, the project team made a minor revision to the storyboard to address a number of immediately obvious concerns and issues, such as the size of navigational icons and headings listed in the 12 non-consensus items. This revised storyboard, along with the 12 non-consensus items were then brought to the second Delphi session where all SMEs met and discussed the possibilities for enhancement and improvement. In this session, each of the 12 items was presented to the SMES to elicit suggestions and comments on improvements. The project team collected the feedback and then attempted to collectively reach an overall revision plan for each non-consensus item. For example, when discussing the navigational depth of behavior management content, both the instructional technology professor and clinical psychologist felt there were too many layers of matrix content and the size of pop up windows was too small. In addition, the special education teacher felt the contents were unorganized and difficult to follow. To respond to these concerns, the project team would make direct adjustments to the storyboard (e.g., resizing pop-up windows, labeling the content and chunking each label into a self embedded hypertext window) according to the feedback from the participants. Such adjustments continued until at least 4 SMEs agreed with the design approach. Based on the feedback received from the second Delphi session, the remaining four functional and instructional features of the PSS support modules were finalized as shown in Figure 3. The operationalization of these features will be described in the prototype stage.

Figure 3. Screens shots of Behavior Matrix's four additional system modules



Interactive contents module | Skill builder module | Record keeper module | On-line support module

Stage 3: Prototype. In the prototype stage, the PowerPoint based storyboard was converted into a fully functional prototype based on the proposed design strategies and data collected in both assessment and design stages. The development tasks involved in this stage were, for the most part, technically driven, and involved tasks such as database integration and system module assembly. Data in this stage were collected from users using a series of one-on-one usability tests to (1) detect any usability problems associated with system navigation and interactions, (2) determine which features in the system prototype could be improved to become more workable (or complete) for the field testing, and (3) assess users' initial reaction toward the prototype. The usability test provided users with a set of navigational tasks, and the users were then observed to assess how they performed the tasks, what errors they made, and how they reacted to the prototype.

For convenience and cost purposes, seven participants from the original participant pool of thirteen who resided in the Chicago area were selected for the usability test. Determination of this sample size was based

on Dumas and Redish's (1999) usability guidelines, which recommend five to twelve participants to attain reliable usability information to validate the prototype. The usability test followed the task-based usability procedure, and was used to measure the time needed to complete a set of required tasks, record the number of steps needed to complete the tasks, as well as to record any errors produced (Dumas and Redish, 1999). At the beginning of this test, we briefly introduced the system to each participant. Once the participant understood the purpose of the prototype and its functionality, he/she was asked to perform a set of tasks that required interaction with the system's functions. An evaluation aid containing evaluation tasks, operating questions, and a quick reference to the system interface was provided to guide the evaluation activities. After the usability test, a brief discussion with the participant was carried out to ascertain overall feelings about the prototype and to solicit suggestions for improvement.

Major findings of the system usability tests included navigating and finding information throughout the matrix and its relevant content information from the knowledge database, interpretation and accuracy of visual information representation, and general use of navigation panel (e.g., search, print, bookmark, save, system module navigation).

Stage 4: Planning. In the planning stage, the major task was to prepare the system for the field test. Therefore, data collection in this stage was mainly a review of system dissemination procedures. In reviewing the system dissemination procedures, three major tasks were considered: system requirements planning, system assembling, and system packaging. Each task involved a number of factors that concerned the system delivery mechanism and playback. The process of system requirements planning involved review of the user profile survey data and phone calls to the participants' school computer lab administrators to inquire about their schools' technology infrastructures. Based on the information gathered, dissemination considerations were made to ensure the final system prototype would be compatible with the participants' computers. These considerations include use of a compatible medium to package the system prototype (i.e., CD-ROM in MAC and PC hybrid format); simplified installation process without the need for a computer administrator account (to bypass the computer's register system); prescanning for viruses to ensure safe system operation; and transferability of user record files so that participants could use the system both at work and at home without losing their development data. Based on these considerations, the final system prototype was compiled into a compressed installer on a hybrid CD-ROM. A stand alone quick start jobaid (in addition to the system's embedded help system) to help the participants use the system prototype was also included on the CD-ROM.

Stage 5: Action. In the action stage, the main task was to implement the system prototype in the participants' work environment to identify potential practical constraints that could hinder the use of the system in a real-world setting. Prior to implementing this stage, a 30-minute training session on the use of the system was delivered to participants to help them become familiar with the system usage.

Following the training session, all 13 participants were asked to use the system whenever they encountered classroom management problems with their students over the course of the subsequent two months. The process of asking participants to address real-life problems as a learning exercise is similar to action learning. As such, we divided the participants of this study into three groups based on their school affiliation, and the project team invited each group to form an action learning set where group members could collaborate via the system prototype in developing intervention strategies for their students' behavior problems. A behavioral psychologist from the primary researcher's company was designated as the set advisor to facilitate the action learning process. While the participants were carrying out the action plans they had developed for their students' behavior problems, they addressed the issues of implementation with the set advisor and their group members.

In the beginning of the action stage, the set advisor created a "Scavenger Hunt" through some of the system modules to familiarize participants with its contents. It was intended to be completed quickly, yet also ensure that all participants viewed important sections of the system. It was also intended as a tool to facilitate thinking about how they could use it in their groups.

After the participants were familiar with the system, all three action groups were encouraged to use the system as often as they wished. Weekly on-line discussions were conducted by the set advisor to answer participant questions that arose in the process of applying the interventions in their classroom environments. Overall, according to the set advisor, participants commented that the matrix metaphor provided a quick reference for their routine classroom behavior management tasks. Participants used the matrix to either support and confirm the intervention strategies they developed from their background knowledge or find alternative interventions for problems they encountered in the classroom. They reported feeling more confident and informed when using the system to make intervention decisions and when preparing to search for information from both the Internet and book resources. Participants reported (to the set advisor) that the elaborated and inductive way of finding relevant information for their classroom behavior management issues (e.g., from behavior matrix to interactive contents to record keeper) gave them a sense of control over the information.

Also, the structure of the information (i.e., each intervention included in the behavior matrix included a description of the intervention, when to apply it, how to implement it, and how to evaluate it) provided assurance and credibility of the information queried.

Another noteworthy finding was that, according to the participants, the behavior matrix was the key feature that integrated the system modules. Participants would use the matrix to diagnose the issues in their classroom with other system modules serving as supporting resources to help them understand and manage their interventions. Furthermore, the format and information query structure provided in the behavior matrix guided them to systematize their development of interventions (e.g., degree of intrusiveness) and to create a dialogue for exchanging ideas with other teachers as well as with parents. Participants were able to discuss, refer, and use their interventions based on a common understanding that was laid out in the matrix. When applying the behavior matrix, the participants also used other system modules as supplements to help them understand the background information for the interventions and to retrieve more relevant information or strategies that could be used to develop more thorough interventions. For example, participants would start with the behavior matrix to help them recognize the problem in context and then systematically develop the intervention strategies obtained from the matrix. If more information were needed, participants would explore the strategies further through a direct link to the interactive contents and skill builder modules to learn additional information about the developed intervention strategies. Information gathered could also be saved in the record keeper module for future reference.

However, concerns were also raised when applying the list of interventions and information presented in the system. In particular, participants were concerned about the rigidness of the matrix and lack of environmental components in the system. Participants felt that the matrix design, by providing quick cross reference and instant possible solutions to the target behavioral problems, at times it forced them into choosing interventions that were a reflection of the situation as it had occurred. That is, the one-to-one matching process (one behavior to one intervention at a time) inherent in the grid design approach could potentially lead a participant to feel the suggested intervention was dictatorial; this was quite evident because the situation was somewhat? ill-defined and could not be justified without contextual information. Additional grids such as environmental conditions and cognitive conditions of the child may be necessary to give the system a more comprehensive look. In addition, tutorials and instructions that advise new users about the adoption of the interventions should be provided to minimize the authoritative look of the system.

Stage 6: Audit. After the field test, questionnaires on system impact, interviews of participants' experiences and perceptions, and analyses on activity logs were carried out to assess the system design framework for supporting participants in making informed decisions, and to create a better way of integrating a fully developed system into the classroom environment. The questionnaire included 52 Likert response scale, short-answer, and open-ended items. These questions were derived from conversations, informal interviews, previous research and literature reviews (e.g., Redmond-Pyle, & Moore, 1995; Shneiderman & Plaisant, 2004). The purpose was to elicit participants' opinions about the system and to characterize the overall value of the system in a quantitative manner. The questionnaire was composed of five constructs: (1) system operability and appropriateness for participants' work environments, (2) system navigation and orientation, (3) system interface and content arrangement, (4) overall system usefulness, and (5) readiness for system adoption. Upon completion of the questionnaire, each participant was interviewed to gather more in-depth, qualitative information regarding his or her experience with the system.

All 13 participants answered the survey at the end of the field test. Overall, participants had positive reactions to the system prototype and most of them indicated they would continue to use the system when it is fully developed. Specifically, they felt that the matrix metaphor was easy to use and not overly complex. They reported that the interaction and feedback provided adequate information to inform their actions. The grid based interface was seen as legible and promoted awareness of features that were embedded in each system function. The inadequate support and help to other system modules (i.e., skill builder and record keeper), however, prevented them from further exploring the system in depth. This finding was further confirmed with the system log. The participants' system logs showed that the embedded help function was often accessed within the first five uses of the system with a mean staying time (before jumping back to system modules) of 42 seconds. Additionally, the logs? revealed participants' expectation about each system module's functionality. The participants were interested in identifying the quickest way that the system could support their work. Therefore, the system functions (e.g., behavior matrix, interactive contents, on-line support) that were capable of providing the fastest and easiest way to help users solve a problem became the most-used modules during the field testing.

Upon completion of the survey questionnaire, follow up interviews were conducted to elicit more detailed information concerning system improvement. Each participant was interviewed via phone; these interviews lasted from 10 minutes to 15 minutes. Prior to the interview, participants' answers to survey questions that addressed views on system adoption were reviewed by the participants and primary author to establish the question context quickly. Overall, the findings can be summarized into two major approaches that

concern the next iteration of system development: authority of content and user customization of system features. Some participants felt that the content presented in the system was written in "academic" language, and they suggested the content be revised so that they might more easily transfer what they had learned. In addition, the participants questioned the “fitness” of the intervention strategies listed in the matrix. Participants, particularly those whose responses indicated non-adoption of the system in the future, were concerned with the rigidness of the system’s grid interface and hierarchical structure. They felt the matrix inferred with what could be done when the issues are complex and require multiple aspects. Without proper guidelines and training, they were concerned that the system could easily become a “recipe-like system,” particularly for less experienced users. Therefore, they suggested that additional instructions or hints such as the incorporation of environmental concern and individual differences should be provided to help users make better decisions, and the intervention list should be reorganized to provide a better fit for their classroom environment.

Such suggestions lead to the question of user customization. Most participants would like the matrix to be user customized, with allowance for additional content grids and interventions. Also, an individual’s behavior matrix might be generated so that could the user is able to customize the interventions to individual students and thereby integrate the system with each student’s IEP.

Conclusions

The results of this study yielded the following conclusions: 1) Overall, subjects confirmed that the format of the matrix provided them with a quick reference and a guideline to help them more accurately categorize their students’ disruptive behaviors and apply proper intervention strategies. The reasons given were the matrix’s grid and hierarchical structure which enabled users to systematically and sequentially select and organize information and strategies that best fit the problem encountered. 2) Subjects reported that by using the *Behavior Matrix* system as a guide to develop their intervention strategies, they were able to establish common ground and communicate with parents and regular classroom teachers using the same language. When there was a need to increase the degree of intrusiveness of the interventions, all participants were able to look at the matrix and come up with a decision about which intervention strategy they would apply. While all subjects had a very positive reaction to using *Behavior Matrix*, there were concerns abut its practical implementation in the real-life setting: 3) The change process is very long term -- while conceptual understanding and reflection on the behavior management of others comes fairly rapidly, the development of those intervention skills (the ability to reflect in action) requires long term effort. 4) Central to the change process is the ability to discuss strategies and techniques. *Behavior Matrix* may be useful for the users’ just-in-time problem solving, but its rigidity and grid format may inhibit their deeper understanding of the underlying principles of the applied strategies and techniques. 5) Also central to the change process is ready access to the *Behavior Matrix* (to models and reflections on intervention strategy development) -- ideally accessible from home or other non-school sites, e.g., libraries – which could not be assured.

In addition, the adoption of developmental research methodology has shed some light on the process of instructional system development. Though the present research methods resembled the formative evaluation of an instructional product, information collected during developmental research is primarily used to inform instructional designers of how particular problems have been solved or overcome (Reigeluth & Frick, 1999). The three design approaches proposed in this study, combined with their theoretical assumptions, were devised and justified through a series of inquiry, analysis, development, and test processes. The shaping of an instructional product during its development process provides an opportunity to better understand how instructional principles can be used to increase that product’s learnability. In addition, this process uses continual revision to attain effectiveness, feasibility, and acceptability for the product. Thus, this shaping process provides one analytical method for carrying out the developmental research methodology.

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Advance Organizers and Matrix Information Structure: Toward an Instructional-Scaffold Interface Design Framework for Performance Support Systems

Wei-Chen Hung
Northern Illinois University

Chia-An Chao
Indiana State University

Abstract

As a computer-based interactive guidance and information-support system, performance support system (PSS) has been used to support learning and performance in various settings. In this study, major interface design approaches for PSSs are reviewed and critical shortcomings of technology-driven PSSs are identified. In addition, a new design framework for PSS based on Ausubel's advance organizers theoretical framework and a multidimensional information display structure are proposed. This new design framework, Matrix Aided Performance System, was field tested and the results reported in this paper.

Introduction

Performance support systems (PSS) have been adopted as an alternative to the design and development of computer-based learning for several reasons. A PSS has the ability to (1) offers advice and support tutorials for problem-recognition, concept identification and task management; (2) allow users to easily access carefully selected and organized information resources; and (3) provides analytical tools for users to evaluate their action plans. In other words, a PSS' flexible and powerful modular design approach gives PSS designers a variety of options to create performance support tools most appropriate for the users' work environments. A PSSs' unique toolset design approach allows designers to incorporate multiple learning and performance modules (e.g., domain knowledge database, advisory system) to improve users' job performance (Barker & Banerij, 1995; van Schaik, Pearson, & Barker, 2002).

While the toolset design approach of PSSs offers a great deal of flexibility that many PSS designers desire, to integrate all system modules, designers must work hard to develop a unified system interface (Barker, & Banerji, 1995; Gery et al. 2000; Laffery, 1995; McGraw, 1995; Raybould, 1995, 2000; Ring, 1994). A unified system interface, along with a coherent system architecture, are required to support effective user interaction with various system functions. The system interface works hand-in-hand with system functions that monitor and interpret user actions and provide appropriate responses to the user to ensure a positive user experience. A good example is Internet surfing using the web browser; the user does not need know HTML or how the Internet works in order to search and retrieve information. In this instance, the Internet browser serves as the unified interface that allows users to locate information they need from various sources in a variety of formats.

Gery (1995) emphasizes the importance offering "intrinsic support" to users; she contends that in order for users to focus on their task at hand, the interface design must allow user to control their interactions with the system with ease. The goal of a unified system interface is to allow users to interact with, generate, store, and retrieve information contained in various system modules without sensing disparity or disconnection.

Overall the years, there have been significant improvement in interface design, and various guidelines for addressing various interface design issues such as user and system interactions, navigation, orientation, and information storage have been offered. However, there are still two major issues concerning support for user performance that have yet to be addressed:

1. Comprehension–PSSs that employ a variety of advanced technologies may have powerful system functions and provide users a wealth of information in various modules, but they may result in a steeper learning curve that requires the users to possess a higher level of content and system knowledge before they can comfortably use such a system.

2. Scaffolding–Another PSS design challenge is to provide guidance for the users and to help them anchor their knowledge and skill acquisitions in meaningful contexts. With a thoughtful interface design, some PSSs may be able to simplify user navigations and minimize the prerequisite knowledge for users to effectively use the system. However, there remains the problem of helping users to integrate queried information in the context of their work environment and critically examine the usefulness of that information.

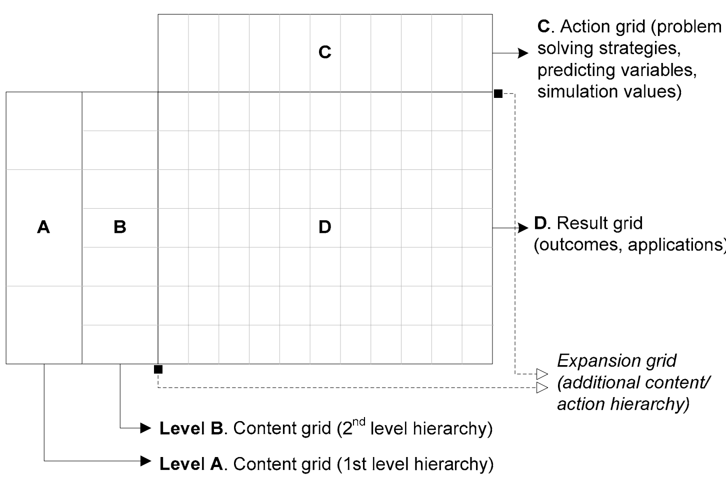
To address these design shortcomings, we are proposing an alternative design framework called Matrix Aided Performance System (*MAPS*). The design concept of *MAPS* is based on Ausubel's (1963) meaningful reception learning theoretical framework (i.e., advance organizers and subsumption theory) with the incorporation of PSS technologies and a multi-dimensional, matrix information presentation structure. The goal of *MAPS* is to operationalize the advance organizers concepts to create a truly instructionally-guided PSS interface to support users' cognitive activities such as information comprehension and synthesis, to scaffold problem diagnosis and solution creation, and to promote self-directed learning.

How *MAPS* Works

As described in the above section, the *MAPS* design framework combines the advance organizers instructional design strategy, PSS technology, and graphical user interface design principles. As a PSS design framework, *MAPS* adopts an interdisciplinary approach. We believe that to effectively support certain types of user task (such as those requiring understanding, synthesis and application of complex concepts), we can borrow from instructional design principles. In other words, the ultimate goal of *MAPS* is to enhance user performance, and pedagogy can be used as a means to achieve that goal. In some cases—depending on the knowledge domain and user performance objectives—*MAPS* can be used to support knowledge and skill acquisition prior to task performance, as well as a reference and task execution tool during job performance.

To illustrate the *MAPS* design approach, a schematic, generic template is used to demonstrate how *MAPS* works (Figure 1). As shown in Figure 1, the content and action grids are used to present users an overall structure of a knowledge domain or the "big picture" before delving into details in individual result grids. This is based on Ausubel's (1963) advance organizer theory. In addition, the matrix structure of information is an effective way to condense lengthy information and to aid in logical problem solving. The multidimensional information display enhances user comprehension of complex concepts and their application in appropriate contexts.

Figure 1. Matrix Structure of *MAPS*



As shown in Figure 1, a generic *MAPS* interface contains four major grids and each grid can be expanded to accommodate the unique requirements of different knowledge domains. Grids A and B are content grids and they are used to display the hierarchical structure of the content materials. Much like a table of contents, grid A is used to present the first-level headings of the content or knowledge/skills, and grid B can be used to display the subheadings or further breakdowns of the knowledge/skills. Additional levels (i.e., 3rd level subheadings) can be added based on content analysis and instructional needs. Each content grid can be color-coded and/or use a different font style to

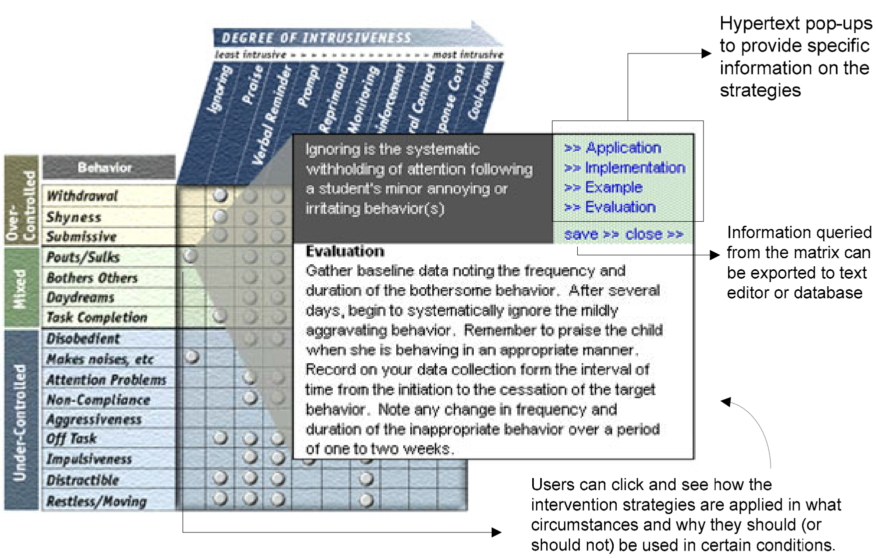
provide visual cues to highlight the structure of the information presented. Information in grids A and B serves as the advance organizers for the learning materials to raise learners' cognitive awareness of the relationships (whether it is hierarchical, causal, conceptual, or comparative) among content units.

Across the top of the matrix is grid C. It presents action information, such as possible problem-solving strategies to support users' problem-solving activities, predicting variables for analytical type performance support, simulation values for laboratory experiment or operations management decision support, and diagnosing steps for engineering troubleshooting. Each action item in the action grid corresponds to one or several rows of information in the content grids so that users can see the utility of the knowledge presented in the content grid. The arrangement of action information (displayed from left to right) is ordered by the range of effects or the degree of power of the actions/strategies, and the order can be determined by experts in the respective fields so that users can experience the experts' problem-solving process. This visual presentation of content and action information serves as a cognitive framework and provides a mechanism for users to externalize their meta-cognitive processes and, hence, open them for evaluation. The matrix enables the users to compare their own problem-solving processes with those of an expert and other users through peer interaction functions in the PSS.

Grid D presents the result of the action such as detailed descriptions and applications of problem-solving strategies and/or variations in strategy applications depending on the context. This grid will show whether an action is appropriate for a particular component information/skill. Due to the limitation of screen resolution and font sizes, each cell in the result grid can present only dyadic information (i.e., "yes" or "no"). However, this information display restriction can be overcome with hypertext technology; by allowing user interactions with the result grid (e.g., clickable cells), additional information can be retrieved and displayed for the user.

Two working examples, *Behavior Matrix* and *Customer Communications Matrix*, are presented below to demonstrate applications of the *MAPS* design framework. The *Behavior Matrix,* as shown in Figure 2, is a behavior management tool for helping k-12 teachers diagnose and manage children with behavioral problems. This behavior management matrix was designed in collaboration with content experts to provide in-service teachers as well as parents with a condensed behavior management guide that compares a variety of intervention types and their applications to address specific behavioral problems. Teachers can use the *Behavior Matrix* to learn a systematic process for solving various behavioral problems. The *Behavior Matrix* can serve as a starting point to help in-service teachers and parents emulate the experts in systematically diagnosing and managing their students or children's behavioral problems. Also, it can help establish a communication bridge among parents, educators, and experts by helping them use the same terminologies and "speak" the same language.

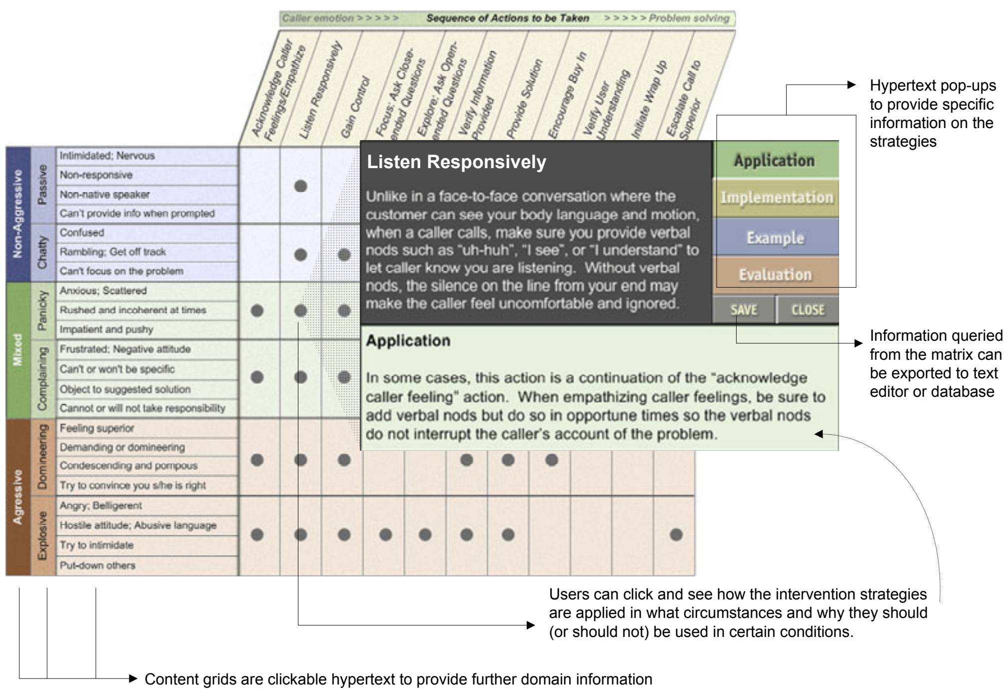
Figure 2. *MAPS* example *(Behavior Matrix*)



In addition to the *Behavior Matrix,* another *MAPS* working example is shown in Figure 3. Adapted from Knapp's (1999) customer communication styles, The *Customer Communications Matrix* displays a hierarchical

structure of caller communication types (non-aggressive, mixed, aggressive) and specific communication styles (passive, chatty, panicky, complaining, domineering, and explosive) in the content grids on the left-hand side of the matrix. Also in the content grid are several indicators for each communication style to help call center staff better gauge callers' underlying emotions based on their verbal behaviors. Once the caller's primary communication style has been determined, the call center staff can refer to the action and result grids for guidance on customer interaction strategies appropriate for the situation.

Figure 3. *MAPS* example (*Customer Communications Matrix*)



Formative Evaluation of Behavior Matrix

The *Behavior Matrix* was evaluated by a group of target audience (n=13) to determine users' perceptions of the *Matrix* design approach in a realistic setting and the effectiveness of this tool in supporting their performance. Another objective of this formative evaluation was to identify any design issues that could hinder user experience and performance.

Each subject was asked to use this system over the course of four weeks and as often as they desired. A user-perception survey and individual interviews were conducted after the four-week period to explore the subjects' experiences using the system and the effectiveness of the system in enhancing their ability to manage their students' behaviors. The user-perception survey included 49 Likert scale items, and 3 open-ended items. The overall Cronbach's Alpha value of the survey is .84. Additionally, principal component analysis with varimax rotation method revealed 9 factors with eigenvalues greater than one (see Appendix 1). These results provided evidences of reliability and construct validity.

Findings

Findings on length of use and adoption intention and motivation

Subjects were asked to indicate average time they spent on the system every week. The majority spend either 1-3 hours per week (five participants) or 3-5 hours (five participants). Only two participants spent more than 5 hours, and one less than one hour. The participant who spent less than one hour noted the reason: her computer was too slow and it was inconvenient for her to use the system any time during the day.

The three open-ended questions explored participants' reasons to continue or discontinue using the system including non-system aspects such as time, hardware, school policy that contributed to their decision to discontinue using the system. Overall, a majority of the participants who intended to continue using the system indicated the system's easy access and quick referencing function contributed to their decision. Here are a few comments from the participants:

> "It was convenient"
>
> "I loved the matrix design. It was a fast and fairly easy way to reflect on my thinking."
>
> "It is consistent, once you have figured out how it works."
>
> "I liked being able to have all of the intervention recorded [the matrix's save function] so that I could go back and reference them if I needed to. I liked the "dot" button. I enjoyed having an elaborated explanation within the cell [hyperlink to knowledge base] so I could see what kind of strategies I can use."
>
> "It was extremely easy to use!!"

While the participants liked the usefulness of the matrix's design and the ease of use, they identified several areas of improvements:

> "At times the amount of information [information contained in the pop-up windows] was presented in an overwhelming fashion. I wished it could be arranged in a more organized fashion."
>
> "The links [hyperlinks contained in pop-up windows] are not clearly identified. It is difficult to navigate the discussion page and to read text in the body of the messages."
>
> "The set up of all the dots was a bit confusing. It was hard to tell which dot was going to which interventions/behavior. It would be very helpful if color is added to the dots or change their shape."
>
> "More behaviors and interventions are needed!"

Lastly, there were some concerns that were not due to the system. Some participants were reluctant to adopt the system due to circumstantial reasons such as lack of technical support to use advance system functions (especially the database functionality) and concern of school district's policy on the use of the system in their classrooms:

> "I prefer talking to people face-to-face or at least in a way that I can hear a voice."
>
> "It [the list of interventions] needs to be approved by our district before I can use it for my IEP [Individual Education Plan]."
>
> "Difficulty knowing which record was [related] to what student at times"
>
> "It was hard for me to use because I am not regularly logged onto a computer."

Findings on subject's perceptions of the system design

The user survey and interviews revealed the following information. *The subjects' perceptions of the system's usefulness and appropriateness for their work environment, and the appearance of system interface and content arrangement:* The subjects' answers to the quantitative survey items and the qualitative interview questions on their overall experience with the system indicated that the *Behavior Matrix*'s functionality, content quality, screen appearance, and interface design were well received. The majority of subjects felt that the screen layouts were effective in supporting their navigation in and interaction with the system. They felt that the system's interface (mouse, buttons, icons, and dialogue boxes) was intuitive and they felt secure and comfortable when interacting with the system. However, some subjects felt that the content presented in the *Behavior Matrix* was written in academic language, and the subjects suggested the content be revised so that they can more easily apply and transfer what they learned from the system to everyday classroom settings. In addition, the subjects had mixed reactions to the complexity of some of the system's functions such as the database and text export functions. Most of them pointed out that more instructions on using these advanced system functions were necessary.

The subjects' perceptions of the ease of system navigation and orientation: The subjects agreed that it was relatively easy to get started and that they were able to begin using the system in a very short amount of time. As to the orientation of the system, the subjects felt that the grid layout was easy to follow and remember, and that the matrix design was effective in supporting their task performance. The straightforward information structure allowed them to executive information search and retrieval tasks in a reasonable number of steps. Furthermore, they pointed out that the knowledge base function was helpful and self explanatory. However, the subjects expressed some frustrations when they tried to explore more advanced system functions (record keeper and on-line support) through trial and error.

The subjects' perceptions of the system's operability: Overall, the subjects were satisfied with the system's response time, its tolerance of user errors and its auto-correction functions. In addition, the subjects agreed that the

system accommodated the needs of both experienced and inexperienced users. However, the subjects had mixed reactions about whether the system should provide explanations and warnings about users' errors. Some subjects felt that the system was fine without providing any feedback after users had executed a task while the others considered feedbacks were necessary. For example, when a user selects the *Save* function (see Figure 3), the system should confirm that the selected content has been exported.

The amount of user training and support in the system adoption process: The majority of the users felt that the amount of user training and support was adequate. However, they pointed out that more time should be spent on the more advanced system functions. When asked about their willingness to continue to use the system after it was fully developed, eight subjects strongly agreed that they would adopt it. Other subjects were reluctant to adopt the system due to circumstantial reasons such as the lack of technical support to use advance system functions (especially the database functionality) and concern of school district's policy on the use of the system in their classrooms.

Subjects were also asked to record their activities using a log sheet and to install the usage tracking function. However, many subjects did not comply with these two data collection requirements because they did not have the time to manually enter information onto the log sheet and others forgot to install the tracking function. Only two sets of log sheets and interaction histories were collected after the field test. Information gathered from these two sets of data was excluded from data analysis.

Discussion

The study findings suggested that the *Behavior Matrix* was a valuable resource for the subjects. The subjects credited the system for helping them deal with behavioral management problems they encountered daily in the classroom and clearly conceptualize students' behavioral problems so they can more systematically document, track and discuss students' behavioral issues with parents and school resources teachers. Besides the useful content, the subjects found the system to be well designed. The matrix information structure and usable screen layout made the task of information search and retrieval intuitive and easy to remember.

While the subjects' feedback was positive and their motivation for adopting the system was extremely high, the findings revealed several areas of improvement. Provision of guided feedbacks so users can fully exploit the more advanced system features (e.g., provide user prompts or wizard function) and expansion of the system's configurable commands and automated controls (e.g., the *save* command needs to be more *intelligent* when appending selected contents to the record keeper) to increase the flexibility and adaptability of the user interface are two improvements for enhancing the effectiveness of the system. Furthermore, offering an expert tutorial to improve users' understanding of the domain knowledge and rephrasing content material using non-academic terms are other areas of improvement.

Conclusion

Interface design and human-computer interaction (HCI) have been areas of emphasis in computer-supported instructional systems and performance support systems where the graphical user interface design and system usability play major roles in the design process. Key concerns when developing a successful and acceptable user interface include: (1) the quality of icons, buttons, and layout to help users reduce information overload; (2) the consistency of interface presentation to lower the chances of confusion, discomfort, and fatigue; and (3) the adoption of an integrated, iterative design approach to continually measure the usability of the system's human-computer interface. Such efforts in an HCI-oriented design approach would certainly ensure a usable interface for a software application, but they are inadequate for PSSs and other types of learning and performance-based instructional systems where learning and performance mastery is the goal. The requirements for a usable interface of a PSS should be extended to include scaffolding and support for user comprehension by presenting meaningfully integrated PSS modules. The MAPS design framework and working examples presented in this report are examples of pedagogy-driven PSSs with unified interface designs that are functionally and instructionally integrated. By carefully assessing and selecting content materials and system functions, and then integrating them using a matrix structure that serves as an advance organizer, the *MAPS* design framework provides both a usable interface and effective performance supports (i.e., comprehension and scaffolding).

The *MAPS* design framework and working examples are examples of pedagogy-driven PSSs with unified interface designs that are functionally and instructionally integrated. Several design considerations and benefits are listed below to facilitate the adoption of the *MAPS* design framework.

1. provide users a holistic view of the knowledge domains related to the problem and their inter-relationships (i.e., with advance organizers),
2. help users recognize common problem patterns and problem-solving strategies (i.e., the hierarchical content structure and action grid), and
3. provide usable interface to help users determine which additional system functions they can use to support their problem solving.

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Appendix: Factor Loadings for Items Regarding Operability, Navigation, Interface, Usefulness, and Adoption

Component Matrix(a)									
	Component								
	1	2	3	4	5	6	7	8	9
System Operability: Compared to your usual approach to behavior management, do you consider BM to be:									
1. On the average, how much time do you spend per week on this system?	0.88								
2. More time-efficient for your development of behavior interventions	0.75								
3. More convenient for you to use	0.53								
4. More important for your group discussion	0.62								
5. More effective for you to use					0.49				
6. Easier for you to manage your developed behavior interventions					0.70				
7. Easier for you to interact with your colleagues	0.51								
8. Providing better communication between you and your students' parents	0.70								
9. Providing less quality of discussion to your colleagues	0.64								
10. Not compatible with my intervention development approach	0.81								
System Navigation & Orientation:									
1. The terminology was clear and precise.						0.51			
2. I always know where to access the information I wanted.	0.42								
3. I feel secure and comfortable in interacting with the system.	0.91								
4. I feel the system responded in a consistent and predictable way.									
5. I feel *BM* provides inadequate guidelines to help solving problem						0.45			
6. I feel *BM* provides inadequate functions to facilitate discussions	0.60								
Interface & Content Arrangement: When using BM, you feel:									
1. Screen and matrix layouts helpful									
2. Amount of information that can be displayed on screen is adequate				0.29					
3. Arrangement of information on screen is logical				0.51					
4. Sequence of screens is clear				0.57					
5. Screen design is appealing				0.22					
6. Amount of graphics is appropriate and purposeful				0.59					
7. Content headings are clearly labeled				0.46					
8. Icons and dialogue boxes are not appropriately sized									
9. More hints should be provided						0.24			

Overall System Usefulness									
1. *BM* helps me understand the nature of the behavioral problem			0.53						
2. *BM* helps me recognize the obstacles associated with the behavioral problem			0.25						
3. *BM* helps me generate hypotheses about the behavioral problem							0.49		
4. *BM* helps me reason the hypotheses that I generated							0.45		
5. *BM* helps me identify the facts of the behavioral problem									
6. *BM* helps me identify the learning issues involved in behavior management								0.20	
7. *BM* makes me feel I can't solve the problem based on the information given									0.41
8. *BM* helps me have a clear understanding how I arrive my final interventions								0.36	
9. *BM* provides me better way to analyze behavioral problem		0.54							
10. *BM* makes behavior management easier to practice								0.23	
11. *BM* prompts me to study the behavioral problem carefully							0.24		
12. *BM* encourage me to identify critical features of the behavioral problem		0.76							
13. *BM* prompts me to give many considerations toward the behavioral problem		0.34							
14. *BM* helps me apply my understanding of the behavior problem to the interventions		0.58							
15. *BM* offers me better management of my thinking process toward the behavioral problem								0.30	
16. *BM* offers me better record keeping of my development of intervention strategies									0.30
17. *BM* are mostly for people who have good understanding of computer			0.34						
System Adoption									
1. *BM* will improve the outcome of classroom behavior management					0.39				
2. *BM* is a tool suitable for classroom behavior management									0.29
3. I would encourage others to use *BM*									
4. I want more training on *BM*					0.59				
5. I would like to continue to use *BM*					0.46				
6. *BM* will weaken teacher-student relationship									
7. Overall, if fully developed, I would like to continue to use the system									
Eigenvalues	7.37	2.22	1.12	2.64	2.63	1.19	1.17	1.09	1.01

BM = Behavior Matrix

Blogging for Reflective Learning in an Introductory Political Science Course

Fengfeng Ke
University of New Mexico

Ying Xie
Pennsylvania State University

Abstract: The ability to thinking reflectively and doing deep learning has been advocated as an essential educational goal in schools and colleges. However, an observation and a pedagogical challenge often found in classes is that students think at the quasi-reflective stage. This paper presents preliminary findings from a research which experiments with the use of weblog to facilitate students' reflective learning in an introductory political science course. Utilizing *Map of Learning*, a reflective learning model, this study explores whether a web-based blogging environment will reinforce reflective thinking and whether students' reflective thinking levels will predict their learning approaches.

Introduction and Theoretical Background

Reflection and Learning

Reflection, as defined by Knapp (1993), is a means for reliving and recapturing experience in order to make sense of it, to learn from it, and to develop new understandings and appreciations. A review of the literature on reflection indicated its value in improving learning and professional practice at different situations, such as experiential learning, reflective practice in teacher education, professional education in counseling, and personal development (King & Kitchener, 1994; Kolb, 1984; Mezirow, 1991; Schön, 1983).

Based on previous works on reflection, Moon (2004) has proposed a hypothetical model, named *Map of Learning*, to synthesize the role of reflection in human learning process. In this model, Moon identifies learning as a continuum ranging from the stage of "noticing," "making sense," "making meaning," "working with meaning," to "Transformative learning" (2004, p. 139). The previous two stages are *surface learning* where the learner simply memorizes new ideas, while beginning at the third stage the learner does *deep learning* by actively integrating new ideas into cognitive structure. In agreement with Mezirow (1991), Moon believes that it is reflection that upgrades learning from surface stages to deep ones. For instance, reflection is suggested to be the means of integrating the learning into the cognitive structure and relating it to previous knowledge; reflection on learning process enables the learner to take a critical overview and accumulate further understandings of the self or the knowledge, hence push him/her into the transformative learning stage.

Moon's model pinpoints the place of reflection in learning, but it hasn't explicitly accounted for different levels or quality categories of reflection and whether levels of reflection will predict the learner's contemporary learning stages (surface or deep). Specifically, since scholars (i.e., Boud, Keogh, & Walker, 1985; Hatton & Smith, 1995; Mezirow, 1991; Taggart & Wilson, 1998) have agreed on a pyramid-shaped model of reflective thinking where reflective process comprises multiple levels (e.g., association, integration, validation, and appropriation), an imperative question naturally posed is, "Will reflective thinking levels predict the learner's learning approaches or stages?" A research in response to such a question is still missing in the field. In addition, Moon's *Map of Learning* is mainly a hypothetical model that is in need of support and clarification from empirical work and in-field observation of reflective activities in a concrete learning environment.

Blogging for Learning Reflection

Journal writing as a means to reflection has been well discussed in the literature and becomes common in learning of different professions. More recently, weblog (or blog), as a new format of journaling tool, has captured the attention of education community. A weblog is a frequently updated website consisting of dated entries arranged in reverse chronological order (Walker, 2003). Quite a few researchers (e.g., Efimova & Fiedler, 2004; Stiler & Philleo, 2003; Williams & Jacobs, 2004) have started exploring the learning-related effects of weblog. For example, Stiler and Philleo (2003) incorporated reflective blogging into the syllabi of two undergraduate preservice courses and found that students using blog were more analytic and evaluative than those of the prior semester. These works offer some valuable discoveries on using weblog to support learning. However, more in-field studies

that focus on weblog as a reflective practice tool and the purposeful design of weblog-based journaling environment are still needed.

Research Purpose

This study intends to explore the reflective learning process in a weblog-based journaling environment. Specifically, the researchers focus on two research questions: (1) Will a web-based blogging environment reinforce participants' reflective thinking? (2) Will participants' reflective thinking level predict their learning approaches or stages, hence their learning achievements?

Research Methods

The current research is a longitudinal study that examines students' usage of weblog over a regular school semester. Data was collected from a content analysis of weekly weblog journals, a self-report survey on students' learning approach, and students' course grades.

Participants

Fifty college students enrolled in an introductory political science course at a major American university participated in the study. All of them were first year students and one-third of them are female. Absence in self-report survey and failure to complete weekly weblog journals led to some subject attrition. The pre-study demographic survey indicated none of participants had used weblog before.

Procedures

Blogging was incorporated into the course syllabi. Specifically, Blogger (http://www.blogger.com), the most widely used weblog, was used in this study. A journaling structure guideline was given to students at the beginning of the semester. This structure guideline was developed by the researchers based on relative reflection theories – Dewey's (1933) five phases of thinking and Johns' (1992) model for structured reflection. Participants were told that the course requirements included the completion of reflective journals using Blogger and they must write at least one journal every week. All participants registered the Blogger accounts using pseudonyms assigned by the researchers. All participants attended a one-hour orientation to learn the usage of Blogger.

Weblog journals were archived at the first and the last school week of the semester. Two sample journals in total were gathered (one at the second week and the other at the last week) and graded respectively for each participant. At the end of semester, participants did the Study Process Questionnaire (SPQ) (Biggs, Kember, & Leung 2001) that measured their learning approaches – surface versus deep learning. The researchers employed the Coding Scheme of Reflective Process by Wong, Kember, Chung, and Yan (1995) in coding weblogging journals and determining the participants' reflective thinking levels. Two raters coded the journals. After reaching 100 percent agreement on scoring the first 5 blog samples, all raters double-blindly scored the rest sampled journals. The inter-rater reliability is .83.

Instruments

Several potential reflective thinking coding schemes were explored to see whether they provided a suitable framework for reflection level evaluation. The coding scheme by Wong et al. (1995) was eventually used due to the following reasons: (a) the coding scheme was developed using the conceptual framework of Boud et al. (1985) and Mezirow (1991), thus matching the current research's theoretical assumption on a pyramid-shaped model of reflective thinking; (b) the coding scheme was in-field tested and the reliability was .88; (c) the coding scheme offered a detailed rubric with clarification of evaluation criteria, hence making its application consistent across different raters and subject contents. The coding scheme classified reflective thinking into seven levels. From low to high, they are *Attending to Feelings*, *Association, Integration, Validation, Appropriation,* and *Outcomes of Reflection.* In the present study, these six levels were coded as rank-scaled score, ranging from 1 to 6, with 0 referring to *non-reflection*.

The Study Process Questionnaire (Biggs, Kember, & Leung 2001) is a 20-item Likert-scaled survey used to determine participants' learning approach in two dimensions – Deep Approach (DA) and Surface Approach (SA). Each dimension is measured by 10 items. The dimension where a participant scores higher (either DA or SA) is considered as the dominant learning approach of that participant. The reliabilities for these two latent dimensions/factors were reported as 0.73 and 0.64 respectively.

Data Analysis

A paired-sample t-test was conducted to investigate whether participants would demonstrate an improvement in reflective thinking level during the blogging process. Then a correlation analysis was used to examine whether participants' reflective thinking level in journaling would predict their learning approaches (as indicated by SPQ survey result) and their learning performances (as indicated by their course grades).

Findings

A paired-sample t-test was conducted to compare participants' reflective thinking level demonstrated in the first online journal and their reflective thinking level in the last online journal. The result is significant, $t(27) = -4.44$, $p < .001$. There is significant difference between the participants' initial reflective thinking level ($M_1 = 2$) and their reflective thinking level after weblogging ($M_2 = 3$). Additionally, it was found that in the initial online journaling, only six (20%) out of a total of 30 students can be counted as "critical reflectors" - demonstrating reflection at one or more of the later three levels, i.e. validation, appropriation, and outcomes of reflection (Mezirow, 1991; Wong, et al. 1995). Then, it turned out that after weblogging 52% of this group of students (14 out of 27) demonstrated one or more of the later three reflective thinking levels in online journaling. Therefore, there is strong evidence suggesting that weblogging improved participants' reflective thinking level. However, it should be noted that the current study didn't involve a control group for experimental comparison. Therefore replicated studies are needed to confirm the positive effects of weblogging on reflection thinking development.

Subsequently, correlation analysis was performed to examine the relationship between participants' reflective thinking level (as indicated in online journals after weblogging), their learning approaches (DA or SA as indicated by SPQ survey result), and their course grades (continuous-scaled). The results indicated a significant positive association between participants' reflective thinking level and their course grades: Spearman's $\rho = .40$, $p = .05$. Therefore, the higher one's reflective thinking level is, the higher his/her course grade is. It was also found that participants' learning approach would predict their course grades, Spearman's $\rho = .54$, $p = .02$. Specifically, participants with Deeper Approach in learning tend to get higher course grade. However, there was no enough statistical evidence suggesting that reflective thinking level may predict learning approach, Spearman's $\rho = .16$, $p = .67$. Therefore, the results of the current study did confirm the claim of previous scholars (e.g., King & Kitchener, 1994; Kolb, 1984; Mezirow, 1991; Moon, 2004; Schön, 1983) on the value of reflective thinking in promoting learning performance. On the other hand, the study didn't indicate enough statistical evidence to support Moon's (1999) belief that it is reflection that upgrades one's learning from surface stages to deep ones.

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Does Responding to Prediction Questions Impact Comprehension of Dynamic Systems?

Khusro Kidwai
Peggy Van Meter
Barbara Grabowski
Frank Dwyer
John Waters
The Pennsylvania State University, University Park, PA

Abstract

In this research we investigate a strategy that can support the comprehension of dynamic systems. 175 students from seven sections of an undergraduate biology class at a large public university in US were asked to interact with instruction about the human heart. The instruction included text, static diagrams and animation developed using Macromedia Flash. Three conditions were set up – Control, Overview and Prediction. In the Prediction condition students were first provided an overview – using static diagrams and text they were given information about three temporally separate stages in the human heart cycle. Based on this information, students were asked to make some predictions about the behavior of the heart. Finally they interacted with the instruction and responded to the test questions. The Control group was not provided with any overview; they were taken directly to the instruction and asked to respond to the test questions. The Overview group was given the same overview as the prediction group but they were not asked to make predictions. Although no significant differences were found across conditions on the total scores [$F (2, 94) = 2.606$; $p = 0.08$], the trend for the scores on all four tests was in the direction expected – students in the prediction group performed better than the other two groups. These results are consistent with earlier research (Hegarty, Kriz, & Cate, 2003)

Introduction

Creating internal representations from reading expository texts is a complex and effortful process (Adams, 1994; Kintsch, 1993; Sadoski & Paivio, 2004). Consider, for example, text about the human heart. First of all the learner has to be familiar with the relevant terminology – that is the learner should be able to identify various parts of the human heart. Next, the learner must know the functioning and purpose of individual parts of the human heart. For example, the learner should know about the functioning of heart valves, i.e. how the opening and closing of heart valves controls the flow of blood in the heart chambers.

Learning becomes especially challenging when the expository text involves *dynamic systems.* Perhaps the most difficult part in learning about dynamic systems from reading expository texts is the understanding of the dynamic aspects of these systems. Different parts (sub-systems) in a dynamic system are causally linked to each other. These sub-systems work in synch to produce the overall effect of the system. Comprehension of the dynamic aspects of the functioning of such systems involves the ability to infer the state of one component of the system based on the states of other components of the systems. Such inferences can only be made if the learner knows how the different parts of the systems are coupled with each other.

Previous research shows that comprehension of dynamic systems is a cognitively complex task. For example, in their research on learning about pulley systems (Hegarty & Just, 1993) proposed that learning about dynamic systems is a two step process. In the first step, learners integrate information locally – they read text, and create mini mental models about a component or a small group of components of the larger system. Global integration occurs only in the second step when learners integrate the mini mental models created previously into the mental model for the whole system.

Theoretical Background

Effect of Text, Static Diagrams and Animations

(Hegarty & Just, 1993) have looked at the effect of text and static diagrams on the comprehension of dynamic systems. While text or diagrams alone were found to be sufficient for learning more factual types of information about such systems, the authors found that a combination of both text and diagrams is particularly effective when it comes to understanding the dynamic aspects of the system.

Animation has also been used in instruction to facilitate learning about dynamic systems, for example (Hegarty et al., 2003). Research findings with regard to the impact of animation on learning are mixed though (Rieber, 1993). In order to develop the instruction used in the present study, a pilot study (n=138) (Ausman et al., 2004) was conducted to identify parts of the instruction where students performed below average. Animation was inserted at these locations in order to facilitate learning of the more difficult content. Instruction used in the present study employs text, static diagrams as well as animation to communicate the content.

Process of Mental Animation

Hegarty (1992) accounts for the mental processes involved in the comprehension of dynamic systems. In this research, the author provided a detailed account of the type of knowledge and learner processes that allow learners to infer functioning of dynamic systems that involve the interplay of several parts. The author proposed and tested two possible explanations:

1. Parallel Processing Explanation: Since in a dynamic system many components of the system work together (for example pulmonary and the aortic valves in the human heart open and close together, or the left and the right ventricles expand and contract together), a mental process that is isomorphic to the functioning of the system would involve mentally animating different components of the system at once.

2. Piecemeal or Serial Processing Explanation: Learners try to understand the functioning of dynamic systems by animating the different components of the system "piecemeal". In other words, this kind of processing involves decomposing the behavior of a complex system into smaller sub processes and then animating these sub process in sequence. To be able to explain the sub processes learners must understand the cause and effect relations between the various components of the system. This also means that to be able to explain the functioning of a component later in the causal chain, the learner must mentally run (or animate) the components and sub-process that occur earlier in the causal chain. Hegarty (1992) refers to this process as mental animation.

Hegarty (1992) found evidence to conclude that learners (at least non-experts) do not process all the movements of the various parts of a system all at once (i.e. learners do not parallel process). Instead learners process the information piecemeal (i.e. serially) by inferring the causal chain of events in the sub-systems.

The relationship between mental animation ability and spatial ability has been studied as well. For example (Hegarty & Kozhevnikov, 1999; Hegarty & Steinhoff, 1997; Mayer & Sims, 1994) have all found mental animation ability to be highly related with spatial ability of learners. (Hegarty & Kozhevnikov, 1999) have called this ability visual imagery – "the ability to form mental representations of the appearance of objects and to manipulate these representations in mind" (pg. 684). In the present study, learners' spatial ability is used as a covariate.

Effect of Responding to Prediction Questions

By means of three separate experiments, (Hegarty et al., 2003) compared the effect of the following conditions on learners understanding of dynamic systems: static versus animated diagrams; static and animated diagrams accompanied with verbal explanations; and predicting motion from static diagrams. On the basis of this research the authors postulated that asking learners to predict the behavior of a dynamic system engages them in the process of mental animation. This in turn helps their comprehension of the system in the following ways: (1) It forces learners to begin to construct mental models, albeit rudimentary. Learners work with these mental models and refine them as they go through the instruction. (2) It provides learners with information about what they understand

and what they do not understand about the system. (3) It induces learners to activate their prior knowledge of the system thus preparing them for the instruction that follows.

In other works, responding to prediction questions forces learners to generate explanations about the functioning of the dynamic system. For example, (Chi, Leeuw, Chiu, & Lavancher, 1994) note that the act of generating “self-explanations” facilitates learning by inducing learners to integrate new knowledge into existing knowledge. (Chi et al., 1994) showed that self-explanation can not only facilitate acquisition of problem solving skills, but also declarative knowledge.

One of the experiments in the (Hegarty et al., 2003) study investigated the impact of asking students prediction questions after they were provided with an overview (text and static diagrams). There was no condition in this experiment where students were provided with an overview (static diagrams and text), but were not asked to predict. In this study we have included an Overview condition. This allows us to separate the effects of extra information provided in the overview from the effects of mental animation that is induced when a learner responds to prediction questions.

Method

Participants

About 175 students from seven sections of an undergraduate biology class at a large public university in US were asked to interact with instruction about the human heart. The average age of the participants was about 20 years; majority of them being sophomore and junior year students. There were more female participants than male participants. The participants were informed that the material covered in the instruction would be on the final exam. On an average the students performed well on the tests that followed the instruction.

Instruments

In the first part of the study participants were asked to take the spatial ability test (Ekstrom, French, Harman, & Derman, 1976). This tests consists of paper folding tasks and card rotation tasks (Ekstrom et al., 1976). Students also took the test for prior knowledge in human anatomy (Dwyer, 1977). Questions on the prior knowledge test, tested participants’ general knowledge of the human anatomy.

In the second part of the study, students in all three groups took the following tests (Dwyer & Lamberski, 1977) after completing the instruction.

1. Drawing Test: The objective of the drawing test was to evaluate participants’ ability to construct and/or reproduce items in the appropriate context. The drawing test provided the students with a numbered list of terms corresponding to the parts of the heart discussed in the instructional presentation. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test the emphasis was on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents.
2. Identification Test: The objective of the identification test was to evaluate participants’ ability to identify parts or positions of an object. This multiple-choice test required students to identify the numbered parts on a detailed drawing of a heart. Each part of the heart, which had been discussed in the presentation, was numbered on a drawing. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.
3. Terminology Test: This test consisted of items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas which have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles.

4. Comprehension Test: Given the location of certain parts of the heart at a particular moment of its functioning, the student was asked to determine the position of other specified parts or positions of other specified parts of the heart at the same time. This test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon.
5. Total Test Score: The items contained in the individual criterion tests were combined into a composite test score. The purpose was to measure total achievement of the objectives presented in the instructional unit.

Instruction

At the beginning of the instruction phase of the study, all three groups were provided a labeled diagram of the human heart (Figure 1).

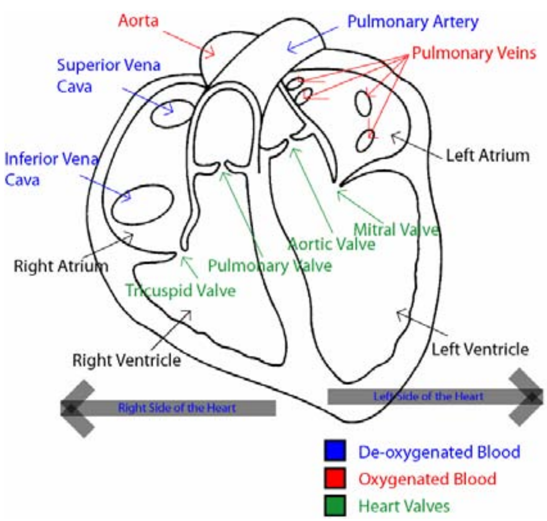
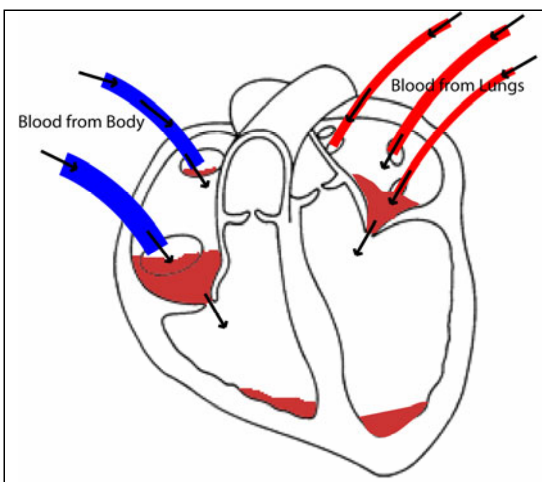
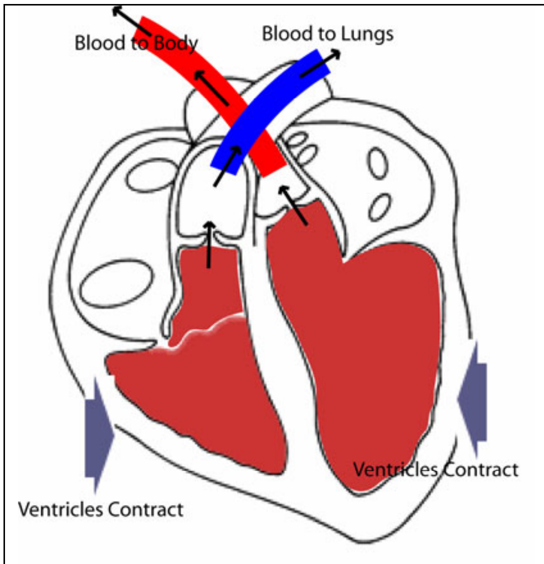


Figure 1. Labeled diagram of the human heart.

Prediction and Overview groups were provided with the following information about three stages of the human heart that are temporally separate:

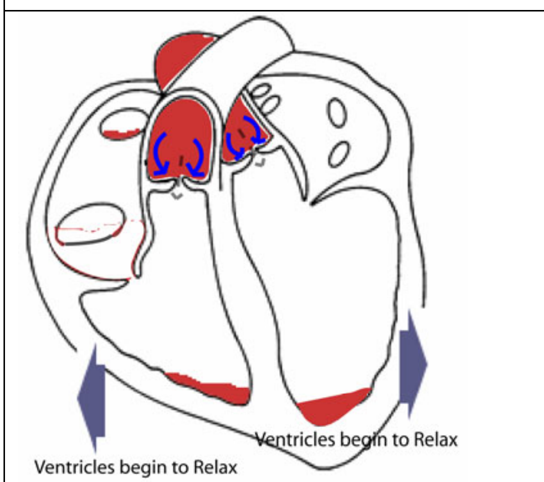


Blood flows into the heart from two sources. Blood returning from the body flows into the right atrium through the superior and inferior vena cava. Blood returning from the lungs flows into the left atrium through the pulmonary veins. While the heart is still relaxed, the blood entering the right atrium flows past the tricuspid valve and into the right ventricle. On the left side of the heart, blood entering the left atrium flows, flows past the mitral valve, and into the left ventricle. The ventricles fill up first, and then the atria fill up.



When the heart begins to contract, the atria contract together and then the ventricles contract together. As the atria contract, the myocardium (heart muscle) of the atria squeeze down against the blood, increasing the pressure inside the atria, and pushing the blood into the ventricles. The ventricles are now swollen with the blood they held initially, plus the blood added by the contraction of the atria. Almost immediately after the atria stop contracting, the ventricles will start contracting. As the myocardium of the ventricles contract, the pressure inside the ventricles increases, and some blood will try to flow back into the atria. This is prevented by the closure of the tricuspid and mitral valves. As the pressure inside the ventricles continues to increase, the pulmonary and aortic valves (semilunar) valves are forced open. Blood in the right ventricle is forced through the pulmonary valve, into the pulmonary artery, and toward the lungs. Blood in the left ventricle is forced through the aortic semilunar valve, into the aorta, and toward the rest of the body.

Blood in the pulmonary artery enters the lungs. From the lungs it goes into the pulmonary veins, and back to the left atrium. The blood in the aorta flows to the rest of the body. From the body into the superior and inferior vena cavas, and back into the right atrium. Thus the cardiac cycle repeats.



On reaching maximum contraction the ventricles begin to relax. Pressure inside the ventricles starts to decrease and some blood is sucked back from the pulmonary artery and aorta into the right and left ventricles respectively. This is prevented by the closure of the pulmonary and aortic valves.

Figure 2. Overview of three stages of the human heart.

In addition to the images and text shown above, the Prediction group was asked to respond to the following prediction questions:

1. Imagine you are in a tiny submarine that has just entered the heart through the right atrium. Trace the path you would travel through the heart and body if you travel with the rest of the blood, finally returning to the right atrium. Students were asked to drag and drop parts of the heart and put them in the right sequence.

2. When you go to the doctor's office, the nurse measures two blood pressures - one higher pressure and one lower pressure (for example, 120/80).
    a) What are the ventricles doing when your blood pressure in 120?
    b) What are the ventricles doing when the blood pressure is 80?
3. A person walks into your clinic with swollen arms and legs. Identify which of the heart valves of this person is not functioning properly.
4. As the ventricles contract, what do you think happens to:
    a) The tricuspid and bicuspid valves.
    b) Aortic and semilunar valves.
5. At the point in time when the auricle pressure becomes greater than the ventricle pressure, what is the position of the tricuspid and mitral valves?

Students in all three groups interacted with the instruction about the human heart (Dwyer & Lamberski, 1977). The instruction employs a combination of static images and animation to support the instruction.

Procedure

The study was conducted in two parts. Students in all three groups were emailed a Web link for Part 1 of the study. In this part of the study, participants completed a demographic survey, and took two tests: a spatial ability test and a prior knowledge test. Participants could complete this part of the study on any computer, anywhere, and at any time before they came to the lab for the second part of the study. Students typically completed Part 1 in 20–30 minutes.

In Part 2, students were randomly assigned to three conditions – Control, Overview and Prediction. This part of the study was carried out in university labs in the presence of the researcher. Upon arrival students were provided instructions by the researcher. During this part, participants first interacted with online instruction about the human heart (30 minutes–45 minutes). After this they took the four post-tests (about 5 minutes each, total 15–30 minutes).

At the beginning of the instruction phase of the study, participants in all three groups were shown a labeled diagram of the human heart (Figure 1). They were given the following instructions:

> "*Before beginning the tutorial, carefully study the labeled diagram of the human heart given below. Try to learn the names of as many parts as possible. We will be referring to the names of these parts all through the instruction.*"

Participants were given 2 minutes to study the labeled diagram.

1. Control group: After spending two minutes studying the labeled diagram of the human heart (Figure 1), students in this group were directed to the online instruction. After this they took the four post-tests.

2. Overview group: First, the students were shown the labeled diagram of the human heart (Figure 1). After this they were shown static images of three phases of the human heart along with text describing the images (Figure 2). Participants were given the following instructions:

> "*It is important that you study this information <u>very carefully</u>, this may help you learn better from the human heart tutorial that follows. Try to understand the functioning of the human heart in such a way that you can explain it to someone else.*"

Finally they interacted with the instruction and responded to the four post-tests.

3. Predication group: First, the students were shown the labeled diagram of the human heart (Figure 1). After this they were shown static images of three phases of the human heart along with text describing the images (Figure 2). Participants were given the following instructions:

"*It is important that you study this information very carefully; this may help you learn better from the human heart tutorial that follows. Try to understand the functioning of the human heart in such a way that you can explain it to someone else. On the next page you will be asked to make some predictions about the functioning of the human heart.*"

This was followed with prediction questions. Students could access the labeled diagram of the human heart as well as the static images of three phases of the human heart along with text describing the images when they answered the prediction questions. In the end students interacted with the instruction and responded to the post-tests.

In all 104 students participated in Part 1 of the study. 137 students participated in Part 2. For the final analysis, we only used that subset of participants who participated in both parts of the study. This number was 94.

Scoring

While the scoring procedure for spatial ability, prior knowledge, identification, terminology, and comprehension tests is objective, the scoring procedure for the drawing test is subjective.

To determine if the scores from the main scorer on the drawing test were reliable, both the main scorer and a second scorer graded responses from the same 20 participants. Responses from those participants that were assigned substantially different scores by the two raters were identified and discussed until a consensus on the score was reached. Although this exercise does not give us an estimate of reliability of the main rater's scoring, it does go a long way in improving inter-rater reliability. We calculated the correlation between the scores from the two raters; this inter-rater reliability measure was found to be 0.97.

Results

We used spatial ability scores as the concomitant variable. One way ANCOVA analysis gave us the following F-values for the four dependent measures as well as the total scores. The adjusted means are also provided along with standard deviations (Table 1).

	Control	**Overview**	**Prediction**	**F values for one-way ANCOVA**
Drawing (out of 20)	Mean = 17.84 S.D. = 2.95	Mean = 18.17 S.D. = 1.80	Mean = 18.68 S.D. = 1.66	$F(2, 94) = 1.088$ $p = 0.34$
Identification (out of 20)	Mean = 18.16 S.D. = 1.90	Mean = 18.94 S.D. = 1.31	Mean = 19.26 S.D. = 1.12	$F(2, 94) = 4.653$ $p = 0.01$
Terminology (out of 20)	Mean = 16.28 S.D. = 3.79	Mean = 17.26 S.D. = 1.98	Mean = 18.00 S.D. = 2.96	$F(2, 94) = 2.599$ $p = 0.08$
Comprehension (out of 20)	Mean = 14.56 S.D. = 3.31	Mean = 15.03 S.D. = 3.03	Mean = 15.86 S.D. = 3.00	$F(2, 94) = 1.005$ $p = 0.370$
Total (out of 80)	Mean = 66.84 S.D. = 10.32	Mean = 68.81 S.D. = 7.34	Mean = 71.61 S.D. = 6.81	$F(2, 94) = 2.606$ $p = 0.080$

Table 1. Results

Discussion

Clearly providing the students with static images of the three phases of the human heart and text describing these images (Overview condition) has an effect on comprehension. Asking students to make prediction based on this information (Prediction condition) had an additional but smaller effect. Although neither of these effects was significant for the total scores, the trend for the scores was in the direction expected – students in the Prediction condition performed better than both the Overview and Control conditions. These results are consistent with earlier research (Hegarty et al., 2003).

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Role of Technology Integration Course on Preservice Teacher's Intent to Use Technology

Kioh Kim
Northwestern State University

Steven Aagard
University of Wyoming

Lee Nabb
University of Wyoming

Abstract

This paper presents the results of a study to explore preservice teachers' progress of their intent to use computer-based technology by taking instructional technology integration course which mirrors the General Preparation of ISTE NETS profiles. This study explores how much the course makes preservice teachers have their higher intent to use computer-based technology and how important the instructional technology integration course at the college is for preservice teachers.

The instrument used in this study was the Intent to Use Computer-based Technology Survey (ITUCTS). The results showed that preservice teachers' intent to use computer-based technology was significantly increased after taking an instructional technology integration course.

Introduction

The researcher has been teaching the course titled "Teaching with Microcomputers" to preservice teachers at a major university in the Rocky Mountain region for several years. This course is a required course in the teacher education program. The researcher observed that preservice teachers' intent to integrate technology in classroom is enhanced after taking this course. In this study, the researcher aims to empirically support his hypothesis.

It is important for preservice teachers to experience computer-based technology integration in college before they become teachers so they have less anxiety and a positive level of intent to use computer-based technology in their classroom in the future. In Schrum's (1999) research, more than 70% of education students were required to take three or more credit hours of technology instruction with an equivalent amount built into their traditional classes. There are researches that suggest that the more positive experience preservice teachers have with computers, the less anxiety and the more positive level of intent they will have towards using instructional technology (Downes, 1993; Koohang, 1989; Savenye, 1992).

There have been many researches that learners have positive attitudes towards using technologies in their classroom. Using technology in educational settings helps students in their learning. In addition, teachers also improve their instruction by using a variety of technology resources such as the Internet, multimedia CD-ROMs, audio and graphics (Jao, 2001). There is no doubt that teaching with technology provides more benefits for both teachers and students than teaching without any technology.

Universities and colleges are the places to train the preservice teachers to comprehensively integrate instructional technology into their future classroom instruction. It is necessary for preservice teachers to be trained instructional technology so that they can use the technology skills in their future classroom as teachers.

This research is to compare preservice teachers' intent to use computer-based technology before and after taking a "Teaching with Microcomputers" class at a major university in the Rocky Mountain region. This class is an introductory course to effective utilization of computers for instruction; software/hardware selection; integrated applications; databases; spreadsheets; word processing as applied to all areas of education.

This course is based on General Preparation of the Technology Performance Profiles for Teacher Preparations of the International Society for Technology in Education (ISTE) National Educational Technology Standards (NETS). The NETS project writing team has created and defined technology performance profiles for teacher preparation across four categories in hopes to use these profiles in the development and improvement of teacher skills and competencies in the area of education technology (SITE, 0000). The four profiles are General Preparation, Professional Preparation, Student Teaching/Internship, and First-year Teaching. "This project, initiated by the ISTE, focused on the development of national standards for various uses of technologies that are associated with school improvement in the United States (Foley, 2001)."

The four profiles are not based on grade level. Instead they are based on the level of skill of people preparing for teaching. The profile called General Preparation refers to students who have completed basic training in instructional technology. “They may be at the lower division level or may have received skill development through on-the-job training, obtaining a degree or experience in a nontraditional program… They are able to perform the tasks that go beyond the classroom setting” (ISTE, 2004). They can operate technology systems, use content-specific tools such as software and graphing calculators, and use technology to collect information and process data.

The Professional Preparation profile has completed intermediate training. “Experiences in this profile are part of professional education coursework that may also include integrated field work” (ISTE, 2004). Before beginning student teaching, students should able to perform at this profile. They identify the benefits of technology and resources available, use hardware and software for specific teaching and learning objectives, and develop a portfolio of technology-based products used to analyze technological resources.

The Student Teaching/Internship profile contains those students who are finishing high level course work and internships to become teachers. They are “completing their final student teaching or intern teaching experience with extensive time spent with students. They are being supervised by a mentor or master teacher on a consistent basis (ISTE, 2004). They can solve problems with routine technology that occur in the classroom, find technology resources to support a coherent lesson sequence, and guide collaborative learning activities to help students solve problems.

The First-Year Teaching profile means that they are ready to teach. “They have completed their formal teacher preparation program and are in their first year of independent teaching. They are typically in control of their own classroom (ISTE, 2004). They should able to choose and arrange for access to appropriate technology systems, resources and services, and “plan and implement technology-based learning activities that promote student engagement in analysis, synthesis, interpretation, and creation of original products “(ISTE, 2004).

The purpose of the study is to explore the effectiveness of instructional technology integration course on preservice teachers’ intent to use computer-based technology in their future classrooms. This research has the comparison of using instructional technology by preservice teachers based on their age, sex, and major between elementary and secondary education. Answering these questions is important to future of education and to produce qualified teachers in K-12 schools. As technology increasingly becomes part of everyday life and all other endeavors, the ability of teachers to teach using technology will affect the lives and well being of all their students.

Recently, students want their teachers to use appropriate technology in the classroom to have better visual literacy, better than chalkboard or whiteboard. Students sometimes have difficulty reading their teachers’ hand writing if their teachers write on the chalkboard or whiteboard like the researcher experienced when he was in K-college. Technology is everywhere and can support learning, and computers support communications beyond classroom walls (Shelly and three others, 2004). Technology can help teachers to improve their instruction, to change the teaching and learning process, to motivate students and to individualize students learning (U.S. Congress, 1995).

The teacher’s role relates to what occurs in the classroom and to what happens to students’ learning. Teacher’s attitudes toward the use of technology can significantly affect their students’ opportunities to learn about technology. In order to help K-12 students, training preservice teachers is the most direct and cost-effective way (Fasion, 1996). In the university setting, designing a course which can effectively train and enhance preservice teachers’ intent to use technology is a direct and cost-effective way to transfer the application of technology from teachers’ training program to public schools.

Methodology

This research aims to explore the effectiveness of instructional technology integration course on preservice teachers’ intent to use computer-based technology in their future classrooms. In order to collect data from the participants, quantitative procedures were used. This section includes a description of the sample, data collection procedures, instrumentation, and data analysis methods.

Sample Description

The participants in this study were preservice teachers who were enrolled in a “Teaching with Microcomputers” class at a major university in the Rocky Mountain region. This course mirrors the first General Preparation as per ISTE NETS profile. Therefore, the participants in this study represent preservice teachers who were taking the first instructional technology course of the ISTE NETS General Preparation. The population for this research consisted of preservice teachers currently in teacher education programs at a four year university and currently enrolled in a technology integration course.

The course has five sections which have a total of 125 students. The course is a required instructional technology courses for education majoring students. Since the participants were taking the course on campus, the researcher requested the instructors for their permission and then researcher administered the survey for the research in each classroom for all five sections. Data collection took place at the beginning and at the end of the Fall 2005 semester.

Procedure

Data were collected in the "Teaching with Microcomputers" courses which were taught by three different instructors. All three instructors of the course allowed the researcher to be in their classrooms for collecting data from the students enrolled in the course. The researcher distributed the questionnaires to each section during the first week of the semester for pre-survey and the last week of the semester for post-survey. The participation of subjects was voluntary in nature. Overall 94 students participated in the study, out of which 61 were females and 33 were males, and 35 students had elementary education and 59 students had secondary education as their major. The age of participants was between 18 years and 46 years.

Instruments

For the study, one survey instrument and a demographic questionnaire were utilized to collect the data from the participants. They are described as follows:

a) Intent to Use Computer-based Technology Survey (ITUCTS): The instrument used in this study was the Intent to Use Computer-based Technology Survey (ITUCTS). ITUCTS was adopted from the writings of Bichelmeyer, Reinhart, and Monson (1998) and Wang (2001).

The ITUCTS is designed to measure beliefs about the teacher's role in teaching with computer-based technology. The survey makes a distinction between teacher-centered and student-centered use of computer-based technology by focusing questions on the perceptions of the teacher's role in a classroom with computer-based technology and the preservice teachers' perceived use of computer-based technology in the classroom.

The ITUCTS instrument is divided into two sections, each section has 12 questions. The first section addresses the preservice teachers' perceptions of their future role in a classroom equipped with computer-based technology (Role). Role of the teacher in the classroom was defined as the manner or style in which the teacher engages during classroom instruction, having a spectrum from, the teacher as an authority figure (Teacher-Centered Role) to the teacher as a learning facilitator (Student-Centered Role). This section uses a Likert scale from (1) Strongly Disagree to (5) Strongly Agree with 12 questions. The second section addresses the preservice teachers' perceptions of how they will use computer-based technology specifically when placed in a computer-based technology enhanced classroom (Use). Use of computer-based technologies in the classroom is defined as either the use of computer-based technology by the students for learning activities (Student-Centered Use) or use of computer-based technology by the teacher in ways that enable the teacher to more easily manage his or her classroom and instruction (Teacher-Centered Use). This second section also uses a Likert scale from (1) Never to (5) Frequently with 12 questions.

The reliability of the section measuring teacher-centered role is .94, the section measuring student-centered role is .93, the section measuring teacher-centered computer use is .86, and the section measuring student-centered computer use is .93 (Wang, 2001). The overall reliability of this questionnaire in this study was found to be .83 and the reliabilities on the sub-scales were found to be similar to the study of Wang (2001).

Data Analysis

Data from ITUCTS and demographics questionnaire were organized in SPSS 13 statistical software to analyze. This study used group comparison analysis to determine the difference between preservice teachers' intent to use computer-based technology before and after they take "Teaching with Microcomputer" course.

Results

The table below shows that there was a significant difference in mean scores of students in pre and post test on Intent to Use Computer-based Technology (Table 1).

Table 1: Mean Difference between pre and post scores on Intent to Use Computer-based Technology

	Mean	S.D.	T
Pre	87.7	8.89	5.21**
Post	92.5	9.04	

**significant at 0.05 level

Further analysis showed that results were insignificant on the role of Intent to Use Computer-based Technology Survey and its sub-scales. But results were significant for the use dimension of Intent to Use Computer-based Technology Survey and its sub-scales.

The analysis showed that there was a significant difference in mean scores of students in pre and post test on the use dimension of Intent to Use Computer-based Technology (Table 2).

Table 2: Mean Difference between pre and post scores on Intent to Use Computer-based Technology (Use dimension)

	Mean	S.D.	T
Pre	42.7	6.32	5.74**
Post	46.5	6.90	

**significant at 0.05 level

The analysis showed that there was a significant difference in mean scores of students in pre and post test on the teacher centered use dimension of Intent to Use Computer-based Technology (Table 3).

Table 3: Mean Difference between pre and post scores on Intent to Use Computer-based Technology (Teacher Centered Use)

	Mean	S.D.	T
Pre	23.7	3.23	3.27**
Post	24.9	3.10	

**significant at 0.05 level

The analysis showed that there was a significant difference in mean scores of students in pre and post test on the student centered use dimension of Intent to Use Computer-based Technology (Table 4).

Table 4: Mean Difference between pre and post scores on Intent to Use Computer-based Technology (Student Centered Use)

	Mean	S.D.	T
Pre	19.0	3.93	6.87**
Post	21.6	4.35	

**significant at 0.05 level

Limitations

The limitation of the study is that the sample of the participants in the study is limited to one specific course and specific university. Hence, these results can not be generalized throughout the country as the sample is not representative across USA.

In the future researchers may improve and add to the results of this research by taking a more representative sample and conducting the research in a more controlled setting.

Conclusion

Schrum (1999) and Schrum, Skeele, and Grant (2002) state that education students should take three or more credit hours of technology instruction with an equivalent amount built into their traditional classes. There are researches that suggest that the more positive experience preservice teachers have with computers, the less anxiety and the more positive level of intent they will have towards using instructional technology (Downes, 1993; Koohang, 1989; Savenye, 1992).

This research proves that preservice teachers' intent to use computer-based technology has been significantly improved after taking the instructional technology integration course.

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Future Trends of Blended Learning in Workplace Learning Settings Across Different Cultures

Kyong-Jee Kim
Portland State University

Curtis J. Bonk
Indiana University, Bloomington

Ya-Ting Teng
SuJin Son
University of Illinois at Urbana-Champaign

Tingting Zeng
Roehampton University, UK

Eun Jung Oh,
University of Georgia

In this session, the presenters will report survey findings related to the current status and future trends of blended learning in corporate settings across different cultures. Surveyed in this study are 568 practitioners in corporate training or e-learning in various workplace settings from four countries – i.e., Korea, Taiwan, the United Kingdom, and the United States. Findings of this survey study reveal which technologies and instructional strategies are currently used for blended learning in these different countries as well as the emerging technologies and trends surrounding the field of blended learning in workplace settings. Also, the perceptions of the respondents regarding the benefits of blended learning and the barriers to deliver it in their organizations are analyzed.

With the emergence of Internet technologies, there has been an explosion of nontraditional learning opportunities during the past few years. This explosion is apparent in K-12 environments, higher education, and government and military training settings (Bonk & Graham, 2006; MacDonald & McAteer, 2003; Young, 2002). Such informal and nontraditional training approaches have also proliferated in corporate training (Cross, in press; Noe, 2003). However, various limitations of e-learning as a training method in corporate settings have led many to try mixing various delivery methods. Accordingly, the interests in blended learning, which is typically combine face-to-face training and online learning, is rapidly increasing (Boyle, Bradley, Chalk, Jones, & Pickard, 2003; Duhaney, 2004; Thomson NETg, 2003; Thorne, 2003). Millions of learners around the planet, in fact, are actually learning in this fashion each day (Bonk & Graham, 2006). Ironically, however, there is minimal known about the resulting learning differences among various blended learning models and the transfer of learning gains from one delivery mechanism (e.g., self-paced online learning to acquire content) and another (e.g., face-to-face classroom training to practice one's new skills in front of others).

Despite the many unknowns, blended learning estimates continue to climb. By the end of the decade, it is conceivable that 80-90 percent of college and corporate training classes will be blended (Kim, Bonk, & Zeng, 2005) and that more than one billions learners around the globe will be advancing their skills in this fashion. Therefore, many practitioners in HRD and corporate training find themselves in a situation where they consider catching on this latest trend of workplace learning but also they have many questions unanswered when it comes to blended learning. In response, we ask the question; where is blended learning actually headed? The present study intends to provide a compass that can mark the direction and intensity of the blended learning approach in corporate training settings. Blended learning is becoming a dominant delivery method for workplace learning across organizations within various sectors and of varying sizes. A recent survey indicates that the use of blended learning in all of training in

the United States will jump to nearly 30 percent during the next year, or about double that of 2004 (Balance Learning, 2004). Some are embracing blended learning as a training method that links learning and performance (Rossett, 2006). There are also expectations that blended learning can create more engaging learning environments (van Dam & Andrade, 2005) and help improve business performances (Harris, 2005).

Although many organizations are recognizing the potential of blended learning to bring learning closer to employees, there are numerous issues to be addressed in delivering blended learning; in particular, in training sectors. First, there are a plethora of technologies and delivery methods that can be used for blended learning in training settings. Indeed, there are many different models and blended learning approaches for delivering training (Rossett, Douglis, & Frazee, 2003). Such a fact can lead to confusion for practitioners in deciding the optimal blended learning approaches for their organizations. Thus, practitioners need guidance on the effective and efficient methods for delivering blended learning. Second, although blended learning has been discussed in global perspectives in higher education settings (Bonk & Graham, 2006), such discussions have been lacking in training settings despite the fact that many researchers and practitioners have emphasized the importance and benefits of global collaboration in education and training. The present study addresses the first issue while exploring instructional strategies and emerging technologies related to the current status and future trends of blended learning in corporate training in five different countries.

Clearly, a study of the future of blended learning and its implications for the delivery of learning for global learners is warranted. In response to this need, a survey was conducted of training professionals (e.g., chief learning officers, training managers, trainers/instructors, and e-learning developers) from diverse cultures on the current status and future trends of blended learning in workplace learning settings.

Review of Literature

Blended learning has garnered a great deal of attention from both education and training settings around the world for several reasons. In education settings, particularly for higher education, blended learning has been recognized as an opportunity to improve the teaching and learning process by complementing the strengths and weakness of face-to-face and online learning settings. Blend traditional teaching approaches with learning technologies, thereby allowing for more interaction between instructor and students or among students than in face-to-face classroom instruction such as large class lectures (Chamberlain, Davis, & Kumar, 2005; Dziuban, Hartman, & Moskal, 2004). Blended learning can also allow increased accessibility and flexibility for classroom teaching, as well as increasing its cost-effectiveness, by reducing seat time in classrooms (Chamberlain, et al., 2005; Dziuban, et al., 2004; Osguthorpe & Graham, 2003). Additionally, some blended learning approaches are adopted as a means to address the dissatisfaction of online students with the lack of sense of community in their online classes due, in large part, to the lack of face-to-face interactions (Lee & Im, 2006; Osguthorpe & Graham, 2003).

Several studies have been conducted to explore the claimed effectiveness of blended classes with that of face-to-face or online classes. Results of several research studies of students in higher education settings suggest that student satisfaction and learning outcomes can be superior in blended learning settings to those in online settings (Boyle, Bradley, Chalk, Jones, & Pickard, 2003; Lee & Im, 2006; Lim, Morris, & Kupritz, 2006). Dzuiban and his colleagues (Dziuban, Hartman, Juge, Moskal, & Sorg, 2006) also report that the learning effectiveness of students enrolled in blended learning courses (i.e., students' academic achievements and their withdrawal rates) are equal or superior to that of students in face-to-face or online courses. Furthermore, some studies suggest that faculty shows a high level of satisfaction with blended learning courses, due largely to increased flexibility and enhanced interactions in web-enhanced environments (Dziuban et al., 2004: Wingard, 2004). Additionally, a meta-analysis of the past studies on the effectiveness of web-based instruction compared to classroom instruction by Sitzmann and his colleagues (Sitzmann, Kraiger, Stewart, & Wisher, 2006) provides preliminary evidence of the effectiveness of blended learning programs by harnessing the effectiveness of the two different modes of instruction; i.e., online and face-to-face instruction.

In addition to the benefits of blended learning reported in higher education settings, HRD and training professionals have touted the potential of blended learning for transferring learning in the workplace setting (Rosenberg, 2006; Rossett & Frazee, 2006; Shaw & Igneri, 2006). A study by Thomson NETg (2003) of learners in both education and training settings indicates that learner satisfaction and learning outcomes - i.e., level 1 and 2 evaluations in Kirkpatrick's (1994) model for evaluating training programs – were higher in blended learning courses than in e-

learning courses. Another key benefit of blended learning in corporate training settings is an increase in the cost-effectiveness of course delivery by reducing the time and costs for employees to travel to participate in a classroom training (Bonk & Graham, 2006). A recent survey of learning professionals in the UK and the US also shows that a majority of learning professionals think that blended learning is the most efficient training method (Balance Learning, 2004). Some best practices and successful blended learning models in corporate training settings have been reported in the literature (Bersin, 2004; Bonk & Graham, 2006). It should be recognized, however, that empirical studies on blended learning in workplace learning settings are still scant. In effect, Shaw and Igneri (2006) contend that more research studies are needed to enhance our understanding of how blended learning can truly improve learning, performance, and retention.

Methodology

This survey was conducted of 568 employees from four different countries (i.e., Korea, Taiwan, Untied Kingdom, and the United States; additional data is still coming in from China). The figure below represents the breakdown of the total respondents by their location of employment (see Figure 1). The participants in this survey study belonged to various types of organizations, including government, business, and not-for-profit organizations. About 40 percent of the respondents were female and 60 percent were male. This survey took place between November 2005 and July 2006 using SurveyShare, a Web-based survey tool. This survey is a part of a longitudinal study of the future of e-learning in corporate training and higher education settings in 2003 and 2004 (Kim & Bonk, in press; Kim, Bonk, & Zeng, 2005).

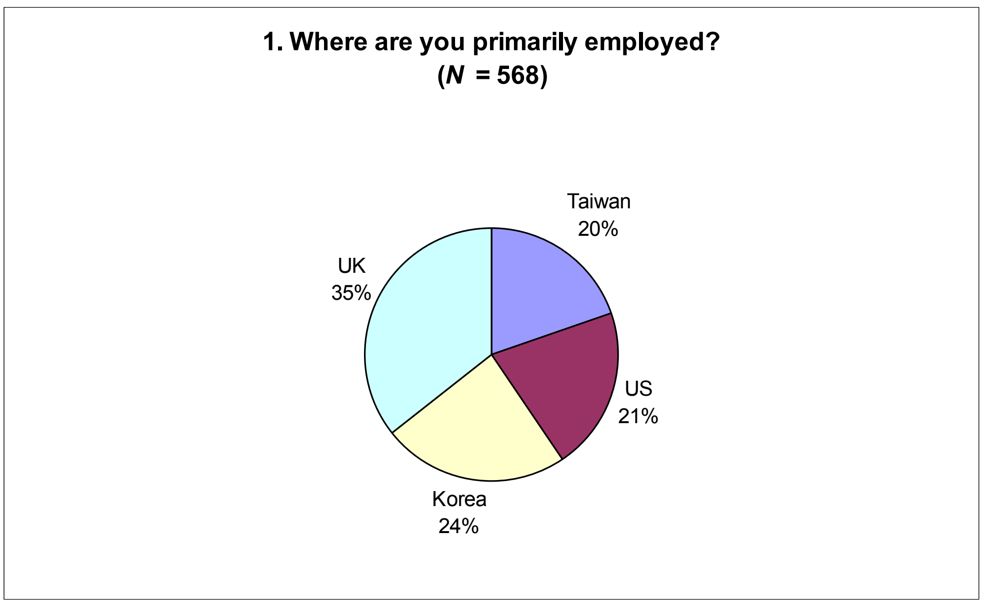

Figure 1. Respondents' location of employment

The survey instrument for this study consisted of 31 items related to respondent demographics, current status of blended learning in the respondent organizations, and future predictions for blended learning in their organizations. Seven investigators, including three from Korea, two from mainland China, one from Taiwan, and one American, participated in developing the survey instrument. To address these international participants, the survey was created in four different languages (i.e., traditional and simplified Chinese, English, and Korean). The survey instrument was developed in English first, and then was translated into other languages by investigators who were speakers of the native language. The translation was then cross-checked by other investigators on our research team or by external colleagues to check for the accuracy of the translation and also for the validity of the instrument. The survey was distributed to several online forums and listservs for training and human resource professionals in the aforementioned countries. Some descriptive analyses (e.g., frequencies) were conducted of the data using a statistical analysis tool provided in the survey system used for this survey.

Findings

The results of the present study indicate that blended learning has become a popular delivery mode in workplace learning settings. 65 percent of those surveyed responded that their organizations were already using blended learning approaches for training their employees and another 20 percent of them indicated that their organizations were considering using it at the time this survey was being conducted. This trend was similar across different countries surveyed in this study, while blended learning approaches were being used the least in Taiwan among the four participating countries. About 45 percent of the respondents from Taiwan reported their organizations were using blended learning approaches. Still, 30 percent of the Taiwanese respondents indicated they were considering using blended learning approaches, which is a higher percentage than that of any other countries being studied. In terms of the future state of blended learning, 68 percent of those surveyed predicted that their organizations' budget spending on blended learning would increase during the next few years. Korean respondents were the most optimistic about their future training budgets on blended learning, with 84 percent of them saying their budget spending in blended learning is expected to increase in the new few years.

What are key drivers for this increasing popularity of blended learning? A majority of respondents reported that improving the quality of the learning experience, an increase in the availability and accessibility of learning, and cost reductions were the major key drivers for adopting blended learning in their organizations. Additionally, nearly 30 percent of those surveyed responded that an increase in the focus related to on-demand learning would promote blended learning the most in the new few years, followed by the blurring lines between work and learning (19%), an increase in the use of real world cases, stories, and examples in training (15%), and increasingly individualized or personalized learning (15%).

In spite of the clear indications of the increasing importance of blended learning in the future of workplace learning, the results of this study also found that there were obstacles in adopting blended learning – mainly limited time and budgets. Interestingly, only 8 percent of the respondents recognized "lack of management support" as a problem of developing blended learning, which was usually viewed as a major challenge of delivering training. Our survey respondents also indicated that their lack of understanding of blended learning is the most important issue that needed to be addressed to implement blended learning successfully. This finding is important because 68 percent of respondents also indicated that blended learning was either important or very important for the strategic planning for training and development in their organizations for the coming years. Ironically, however, only less than a half of those surveyed (49 percent) answered that their strategic plans were addressing blended learning. This trend in the lack of strategic planning on blended learning was almost identical across the four different countries being studied.

One of the most often asked questions that arises when delivering blended learning is what the optimal blends are (Rossett & Frazee, 2006). Figure 2 illustrates the results of this survey regarding instructional strategies that would be widely used in blended learning in the future. Our respondents predicted that instructional strategies that link learning and performance by providing learners with collaborative learning environments and authentic tasks will be used more often in the future. In contrast, didactic, lecture-based learning approaches and Socratic questioning were among the least favored. Clearly, Figure 2 reveals an emphasis on learner-centered, problem-based, and team-based approaches over instructor-centered ones.

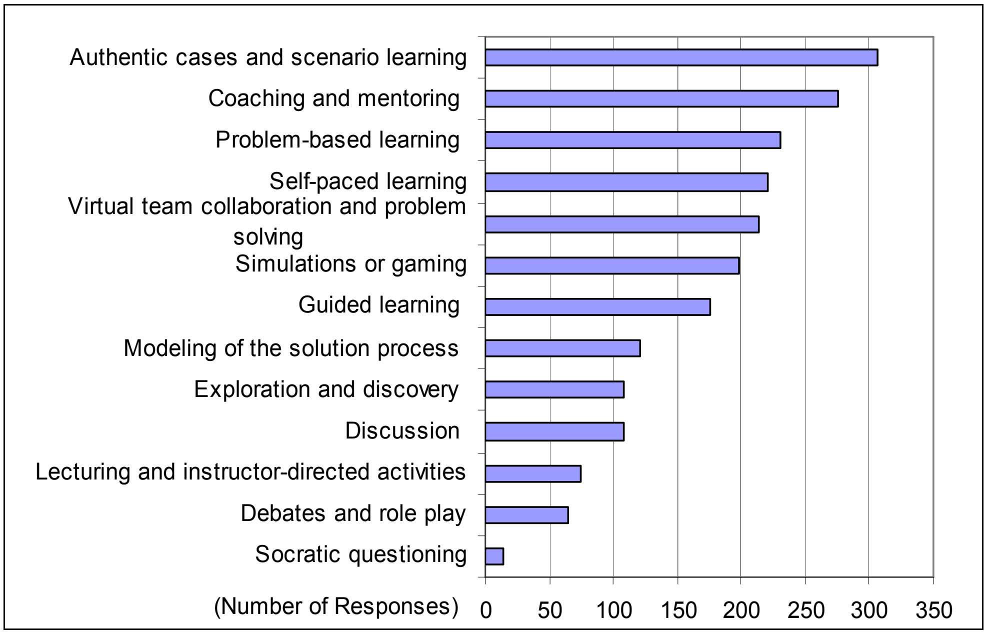

Figure 2. Instructional strategies that are expected to be used widely for blended learning in the next few years.

In another question, we listed 13 technologies and asked the respondents to pick a technology that was expected to be used most widely for blended learning in the future (see Figure3). Our survey respondents predicted that technologies that enable learners for just-in-time training or performance support, such as knowledge management tools and digital libraries or content repositories would be widely used in the future. The respondents also predicted that wireless and mobile technologies would be used widely for delivering blended learning. Interestingly, only a small number of respondents predicted that some collaborative learning tools, such as massive multiplayer online gaming, blogs, and wikis, would be used often in the future. This is a highly interesting finding given the exploding interest in such technologies in the media and in training related conferences and publications. This phenomenon is conceivably associated with corporate security restrictions which are extremely critical in workplace learning (Ardichvili, 2002).

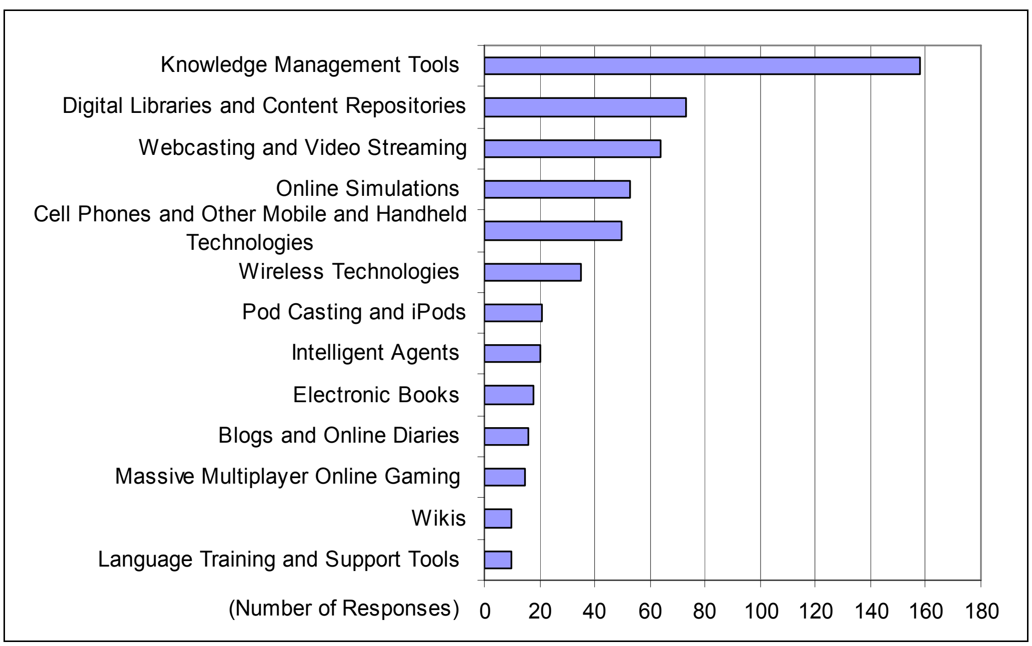

Figure 3. Emerging technologies that are expected to be used widely for blended learning in the next few years.

Another important question for delivering quality blended learning is how it will be evaluated. Survey respondents predicted that the quality of blended learning would be measured most often in relation to its benefits to their organizations such as employment performance, return on investment, or cost-benefit analysis (see Figure 4). It is notable that there is a trend toward evaluating blended learning at a higher level. The results show only 16 percent of the respondents' organizations are evaluating blended learning at Level 3, improvement of behavior. However, 31 percent of them projected that employee performance on the job will be the most effective criteria to measure the quality of blended learning in the future. Also, some respondents predicted that the effectiveness of blended learning would be best measured by comparing learner achievement in blended learning and classroom settings. Furthermore, only about 30 percent of respondents answered that their organizations were evaluating the quality of blended learning. Considering that 65 percent of those surveyed answered that their organizations were using blended learning approaches, less than a half of the organizations that were using blended learning approaches were actually evaluating them.

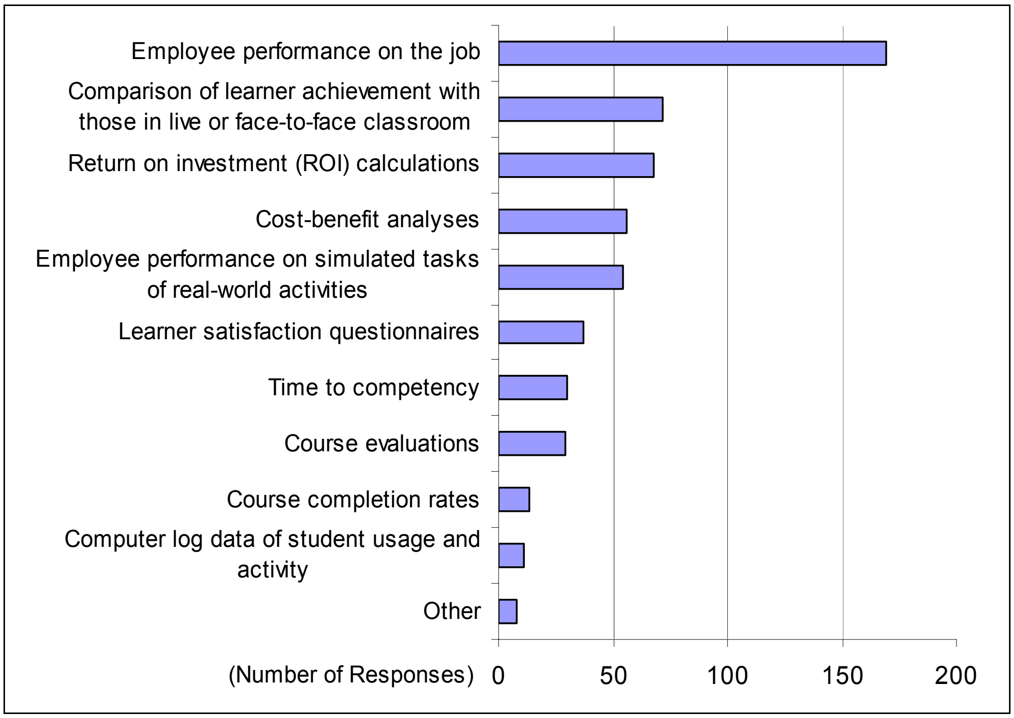

Figure 4. Respondents' predictions on evaluation methods for blended learning in the coming decade.

Conclusions and Implications

In parallel with other survey studies (Balance Learning, 2004; eLearning Guild, 2003), the findings of the present study indicate that blended learning will become a popular delivery method in the future of workplace learning not only in western countries such as the United States and the UK but also in Asian countries such as Korea and Taiwan. Additionally, the results of this study shed light on where blended learning is headed in terms of the instructional strategies and emerging technologies that are expected to significantly impact the delivery of blended learning in the coming years. Despite the strong agreement among the respondents of this survey study regarding the increasing importance of blended learning for the future of workplace learning, they also indicated that they were facing several barriers to implementing blended learning in their organizations. One of the most noticeable barriers or issues that our survey respondents reported was their lack of understanding of the term blended learning.

Apparently, there is a pressing need to provide training and HRD professionals with guidance on how to implement blended learning in their organizations. Consequently, the results of this study should help practitioners to become better informed of how blended learning will be designed, delivered, and evaluated for workplace learning in the future. Moreover, the findings of the present study on the current state of blended learning will provide some

direction for future researchers to address the issues that the training practitioners and managers are facing around the planet. Lastly, since there is scant research on blended learning that compares countries or regions of the world, the results of this study will provide meaningful data and ideas for serious decision making by both training practitioners and researchers related to blended learning around the globe.

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Motivational Influences in Self-Directed e-Learning

Kyong-Jee Kim, Ph.D.
Portland State University

This presentation reports results of a mixed-method research study of working adults and college students who participated in self-directed e-learning courses on what influenced their motivation in their self-directed e-learning. The learner motivation is investigated in terms of what influences the learner motivation and whether the learner's motivational level changes during the instruction. Principles for the design of self-directed e-learning courses to sustain learner motivation are identified from this empirical study.

The Web technology is changing the way people learn, work, and socialize (Bonk & King, 1998). More and more people are turning to the Web technology for their learning needs due to the flexible delivery system of the Web. Although the effectiveness of Web-based instruction has been proven in many studies (Jung & Rha, 2000; Olson & Wisher, 2002), high learner drop-out rates have been a concern in Web-based instruction (Carr, 2000; Cornell & Martin, 1997; Frankola, 2001; Islam, 2002), which also have been the case in distance education and computer-based instruction (Diaz, 2002; Moore & Kearsley, 1996).

Past studies on the factors of learner attrition in distance education suggest that lack of time and lack of motivation are the major causes of that problem. Although instructional designers or instructors do not have control over the learner's time, they can have some influence over learner motivation as it tends to change through instruction (Clark, 2003; Coldeway, 1991; Song & Keller, 1999). Therefore, attention needs to be paid to improving learner motivation to address the issue of learner attrition in Web-based instruction.

E-learning is a rapidly growing market and is expected to be so in the future. A recent survey reported that the U.S. e-learning market in 2002 was $10.3 billion (Adkins, 2002). It is projected that the U.S. e-learning market will grow to $83.1 billion in 2006. Considering this large amount of spending on e-learning, it is imperative that the investment to be worthwhile for the stakeholders. To this end, one needs to present a learning environment that builds success for online learners. Fostering adequate motivation for the online learner is one of the critical factors for creating a successful online learning environment (Hofmann, 2003). Yet, responding to the motivational requirements of online learners is a great challenge due to the lack of interaction in such learning environments (Bonk & Dennen, 2003; Cornell & Martin, 1997; Keller, 1999).

Although the importance of learner motivation in Web-based instruction has been recognized in many literatures (Bonk, 2002; Ritchie & Hoffman, 1997), there is a lack of research on theories and practice of the design of motivating Web-based instruction (Keller, 1999; Song, 2000). Hence, there is a need to identify learners' motivational needs to design motivating Web-based instruction. The purpose of this study is to investigate factors that influence learners' motivation in Web-based instruction, in particular when they take self-directed e-learning courses. Here self-directed e-learning refers to a type of Web-based instruction in which the learner goes through instruction delivered through the Web in a self-paced format without the presence of an instructor. In more detail, this study answers the following questions:

- What influence the learner motivation in self-directed e-learning?
- Does the learner's motivational level change during self-directed e-learning?
- What influences the learner's motivation change during self-directed e-learning?

The results of this study are expected to increase our understanding of the motivational needs of the participants of self-directed online computer training by identifying what influences changes in their motivation to learn in a self-directed learning environment. The results of the study are expected to inform instructional designers of how to design a motivating online learning environment.

Background of the Study

This study investigated learners of self-directed online courses to answer aforementioned questions. Here, self-directed online courses refer to courses delivered via the Web in which learners go through instructional materials delivered via the Web at their own pace without the presence of an instructor. Adult learners can participate in online learning in various contexts, yet the self-directed online learning format is the focus of this study because self-directed online learning is a primary instructional format in training settings for adult learners (Driscoll, 2002; Galvin, 2002).

The courses that the study participants took were offered by a major U.S. e-learning vendor, who offers over 3,000 online courses to 20 million learners per year worldwide. Those courses are offered to adult learners in various educational and workplace settings. The course format is stand-alone, typically 6-8 hours long, self-paced instruction delivered via the Web. The topics covered in those courses include desktop applications (e.g., Microsoft Office products), computer programming (e.g., JAVA, Oracle, MS .NET), soft skills development (e.g., coaching skills, consulting skills), and special topics tailored to the needs of specific organizations or fields.
The learners participated in this study took self-directed online courses either in school or work settings. The learners in school settings took the online courses offered by the university either for personal development or as assigned by their course instructors. The learners in work settings also took the online courses either for personal development or to improve their job skills.

Literature Review

Motivation by definition is the degree of the choices people make and the degree of effort they will exert (Keller, 1983). Past studies indicate that motivation is affected by affective, social, and cognitive factors (Relan, 1992). Keller (1983) identified four components of motivation – i.e., attention, relevance, confidence, and satisfaction - and strategies to design motivating instruction. Clark (1998) developed a CANE (Commitment And Necessary Effort) model that identified two processes of motivation: commitment and necessary effort. Wlodkowski (1993) suggests six major components that affect adult learners' motivation in the time continuum. These motivational models were used in other research studies to identify the gap in learner motivation and how to design motivating instruction.

Several theories have provided theoretical frameworks for understanding motivation (Pintrich & Schunk, 1996). Among different constructs on motivation, continuing motivation and intrinsic motivation are the most significant for instructional theory and research (Kinzie, 1990). Intrinsic motivation is defined as the motivation to engage in an activity "for its inherent satisfactions rather than for some separable consequence" (Ryan & Deci, 2000). Theories of motivation and empirical evidence have suggested several sources of intrinsic motivation. Some motivational researchers posit that activities that provide learners with a sense of control over their academic outcomes may enhance intrinsic motivation (Pintrich & Schunk, 1996). Lepper and Hodell (1989) have identified challenge, curiosity, control, and fantasy as primary characteristics of tasks that promote intrinsic motivation.

Continuing motivation is the type of intrinsic motivation most directly concerned with education and it reflects an individual's willingness to learn (Maeher, 1976). Studies have been done on how to improve learner motivation. Some theorists content that the primary reward for the learner is the activity itself; thus, continuing motivation is facilitated by an intrinsic interest in the activity (Condry & Chambers, 1978). Similarly, Merrill (2002) posits that the primary reward for the learner is learning itself - i.e., when the learner is able to show a new skill or an improvement in a skill, he is motivated to perform even better. He suggests it as an integration component of effective instruction.

It is important to review past studies on motivational issues in computer-assisted instruction and distance education settings, since motivational features encountered these settings are similar to those in Web-based instruction (Song, 2000). Kinzie (1990) argues that intrinsic and continuing motivation are important components in computer-based instruction. Malone (1981) suggests challenge, fantasy, and curiosity as the components of intrinsically motivating computer-based instruction. Song (2000) also argues that three types of motivation – motivation to initiate, motivation to persist, and motivation to continue – are important in Web-based instruction. Studies have been done on the effects of delivery medium to learner motivation. Several researches suggest that motivation to learn via a particular medium is influenced by the learner's beliefs about his own ability and the difficulty level of the task, rather than by the medium per se (Clark, 1994). Similarly, Reinhart (1999) found that the learner's self-efficacy and

task difficulty affects his motivation to learn via the Web. In addition, Keller (1999) posits that learner support is important for motivating learners in Web-based instruction.

Methodology

Participants

The sample for the present study was drawn from the population of adult learners who had taken a self-directed e-learning course in various education and training contexts. A sample of approximately 800 adult learners was selected from working adults and adult students across the United States, who were randomly selected from employees in the client organizations of the e-learning vendor selected for this study, which is alluded to earlier. About 400 learners of self-directed e-learning courses were selected from those who were undergraduate or graduate students enrolled in universities around the United States. Additionally, about 400 learners of self-directed e-learning courses were also selected from working professionals in various workplace settings (e.g., business, non-profit, and government organizations).

The Survey Instrument

A survey instrument (i.e., a questionnaire) was constructed to collect quantitative data in this study. A new survey instrument was developed by undergoing the following three steps to ensure its reliability and validity. First, a preliminary survey instrument was designed based on the theoretical framework that was developed from the review of literature, which was described in the earlier section. Second, the preliminary instrument was modified after a qualitative inquiry was completed prior to the present study in order to include additional motivational factors that were identified from the results of the qualitative research [see Kim (2004) for more information about the qualitative inquiry that preceded the present study]. Third, the survey instrument went through another modification phase after a pilot study was conducted to improve the reliability of the instrument.

The resulting survey instrument has 60 questions, which comprises 59 multiple-choice questions and one open-ended question. This survey instrument is divided into three sections; (1) questions about the respondents' backgrounds (questions 1-13), (2) Likert-type questions to measure the respondents' perceptions of motivational influences in their self-directed e-learning (question items 14-46), and (3) Likert-type questions regarding their motivation to persist in their self-directed e-learning and to continue self-directed e-learning in the future and an open-ended question for general comments about their perceptions of the self-directed online learning environment (questions 47-50). This survey instrument comprised of three a priori scales, which were conceptualized from the theoretical framework through the review of relevant literature (i.e., personal factors, internal factors, and external factors).

Cronbach's alpha was performed on this survey instrument with the data collected from the pilot study to measure internal consistency of the scales included in the instrument. The results of reliability analysis showed that the item on relevance had no strong correlation with any of the three a priori scales in the instrument. To address this issue, I added a new scale on relevance to this survey instrument by adding three more items related to relevance, which were adapted from a motivational questionnaire developed by John Keller, Instructional Materials Motivation Survey (IMMS). By adding a new scale on relevance to this survey instrument, the final version of the instrument comprised of four a priori scales with the reliability coefficients ranging from .78 – .81 (see Table 1). The following table summarizes a priori scales in the survey instrument and the reliability of each scale.

Table 1. A Priori Scales on Motivational Factors in the Survey Instrument

Scale	Question Items	Reliability Coefficient (α)
Personal Factors	16, 22, 23, 26. 27, 31, 33, 40, 41	.79
Internal Factors	17, 18, 20, 28, 29, 34, 35, 38, 39	.80
External & Social Factors	21, 24, 30,32, 36, 37	.78
Relevance	14, 27, 35, 44	.81

Data Collection and Analysis

A message was sent to listservs or e-mail to the sample alluded to earlier to invite them to the survey. The message included information about the study and the URL to the survey site. As a result, a total of 368 individuals

completed the survey, yielding approximately a 46 percent response rate. The respondents took the surveys on the Web anonymously and their responses were stored on the Web server. The data was retrieved from the hosting server and was imported to a statistical analysis program. Descriptive statistics (e.g., means, standard deviations, and frequencies) and inferential statistics (i.e., Pearson's chi-square, correlation analysis, factor analysis, and a multivariate analysis) were performed to analyze the data.

Results

Participants' Demographics and Backgrounds in e-Learning

Of 368 respondents to this survey, 43 percent took the e-learning course as college students and 52 percent took the course as working professionals. The working professionals who participated in this survey belonged to organizations of various types: 45 percent belonged to a business organization, 39 percent belonged to a college or university, and 13 percent belonged to not-for-profit or government organizations. Among 158 college students who participated in this survey, 30 percent ($n = 47$) of them were undergraduate students and 70 percent ($n = 111$) of them were graduate students. Gender was equally distributed among the respondents to this survey: 46 percent were female and 54 percent were male. In terms of age, 18.2 percent of the respondents were 24 years old or younger, 43.5 percent were between 25 and 34 years of age, 21.7 percent were between 35 and 44 years of age, and 16.6 percent were 45 years old or more. Additionally, most of the survey respondents had moderate to high levels of experience in using computer and Internet technologies. Over 70 percent of respondents said they were using the Internet more than 20 hours per week, and 87 percent of them reported that they were using at least 3-5 software programs on a regular basis.

Respondents to this survey study took self-directed e-learning courses on various topics; 48 percent responded that they took a self-directed e-learning course on desktop applications, 30 percent took a course on computer programming, and 22 percent took a course on soft skills. The time that respondents spent taking a self-directed e-learning course also varied; 10 percent of those surveyed responded that they spent less than an hour taking the e-learning course, 62 percent responded that they spent 1-6 hours in the course, and 19 percent responded that they spent 7 hours or more in the course. In terms of the respondents' prior experience with online learning, 30 percent responded that they had had no prior online learning experience and the other 70 percent responded that they had taken 1-7 or more online courses, including college online courses and self-directed e-learning courses. Results of the chi-square test revealed that the respondents in corporate training settings had more experience with online learning than did those in formal education settings [$\chi2$ (1, 366) = 12.770, $p < .05$]. When asked about the frequency of their interaction with an instructor or technical support staff, 31 percent of the respondents indicated that they never had such interactions and another 60 percent of those surveyed responded that they rarely or occasionally interacted with an instructor or technical support staff.

Factors Influencing Learner Motivation in Self-Directed e-Learning

A factor analysis of the thirty-three Likert-scale items on motivational influences in self-directed e-learning was performed using image factoring extraction method with varimax rotation. This factor analysis resulted in seven factors with initial eigenvalues over 1. A reliability analysis (i.e., Cronbach's α) was conducted on each factor to test for internal consistency. Results of the reliability analyses revealed three factors had acceptable reliability levels, which ranged from .651 to .843 (see Table 2).

Table 2. Results of the Factor Analysis and Reliability Analysis on Motivational Factors in Self-Directed e-Learning

Factor	Items	Reliability coefficient
1. E-learning is not for me.	16. I did NOT have enough technical skills to be successful in e-learning.* 19. Some learning tasks in the course were too challenging for me.* 43. I was overwhelmed with the amount of information presented in this course.* 28. I experienced too many disruptions to get through the course.* 31. I would prefer to use other medium for a self-paced course.* 23. Technical difficulties that I encountered while I took this course frustrated me.* 26. I felt anxious or frustrated when I had to take tests or quizzes in this course.* 32. This course format was not suited for my learning style.* 22. I often forgot to go back to the course when I took this e-learning course.*	$\alpha = .843$ ($N = 368$)
2. E-learning is right for me.	35. This course content was useful to me. 36. Multimedia presentations in this course stimulated my interest. 34. Taking a self-directed e-learning course was worthwhile. 44. The course content was relevant to my interests. 30. The course simulated real-world situations. 17. The difficulty level of the course content was just right for me. 46. It was important for me to complete this course. 45. My institution was supportive of my e-learning. 29. Hands-on activities in this course helped me engaged in learning. 40. I received enough feedback on my performance in this course. 42. I was interested in learning through technology as a way to enhance my technical skills. 41. The course Web site was easy to navigate.	$\alpha = .822$ ($N = 368$)
3. I don't want to be all by myself.	33. I wanted to get answers to my questions from an instructor.* 38. I would prefer to interact with peers rather than to learn on my own in an online course.* 39. I needed to be under a deadline to complete this course.*	$\alpha = .651$ ($N = 368$)

*These items were negatively loaded on a factor and were reverse-coded when computing scale scores and reliability coefficients for each factor.

Descriptive statistics were performed on the factors to investigate the mean scores of these factors. The mean scores of these three factors ranged from 3.02 to 3.73 on a 5-point scale (1 = "strongly disagree" and 5 = "strongly agree"), which suggests that the respondents' had moderately strong belief that e-learning was for them, or not for them, or they did not want to do it all by themselves (see Table 3).

Table 3. Descriptive Statistics for the Motivational Factors in Self-Directed e-Learning

Factors *	*N*	Minimum	Maximum	*M*	*SD*
Factor 1	368	1.67	5.00	3.4580	.66509
Factor 2	368	2.00	5.00	3.7310	.46197
Factor 3	368	1.00	5.00	3.0163	.80438

* Factor 1 = "E-learning is not for me."
Factor 2 = "E-learning is right for me."
Factor 3 = "I don't want to be all by myself."

Changes in the Learners' Motivation during Self-Directed e-Learning
The respondents' self-reported overall initial motivational level was high (M = 4.95, SD = 1.272, where 1 = "very low" and 7 = "very high") and their motivational level after they went through some lessons in the course was also high (M = 4.95, SD = 1.333, where 1 = "very low" and 7 = "very high"). When asked how their motivational levels changed as they went through the self-directed e-learning course, those surveyed responded that their motivational levels remained the same (M = 3.01 and SD = .976, where 1 = "decreased significantly" and 5 = "increased significantly"), as shown in Figure 1.

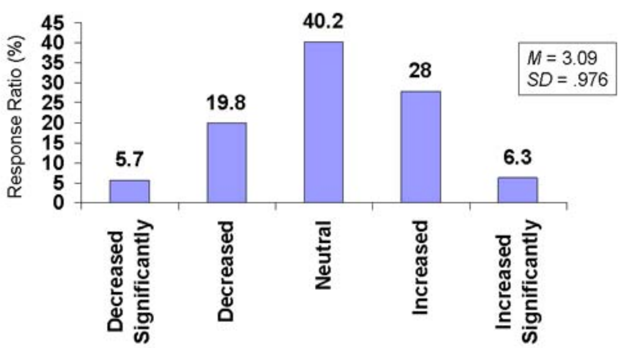

*Figure 1***.** Results of Descriptive Analysis of Learner's Motivational Changes during Self-Directed e-Learning.

Correlation analyses were performed to examine which variables were significantly correlated with learners' motivational change. The results of correlation analysis showed that the learner's motivational change – i.e. an increase or decrease in the learner's motivation level during self-directed e-learning – had a significant positive correlation with his or her satisfaction with the e-learning course (r = .327. p < .01) and with the frequency of his or her interaction with an instructor or technical support staff during the self-directed e-learning (r = .244, p < .01). The learner's motivational change also had a significant negative correlation with his or her age (r = -.107, p < .05), as seen in Table 4. Among the three motivational factors identified from the factor analysis alluded to earlier, only the first motivational factor, "e-learning is just for me" was significantly positively correlated with the learner's motivational change (r = .467, p < .01). The other two motivational factors "e-learning is not for me" and "I don't want to be all by myself" were not significantly correlated with the learner's motivational change, where the correlation coefficients were -.031 (p = .548) and -.020 (p = .706) respectively.

Table 4. Variables that are Significantly Correlated with the Learner's Motivational Change during Self-Directed e-Learning

Variable	Correlation Coefficient (*r*)	Coefficient of Determination (r^2)
"E-learning is right for me."	.467**	.218
Learner satisfaction	.327**	.107
Interaction with an instructor or technical support staff	.244**	.059
Learner's age	-.107*	.011

* p < .05. ** p < .01.

Factors Associated with the Learner's Motivational Change

A multiple regression analysis was performed to identify the factors that were associated with learners' motivational change during self-directed e-learning. The dependent variable for this multiple regression analysis was the learner's motivational change during self-directed e-learning, where 1 = "decreased significantly" and 5 = "increased significantly". Thirteen independent variables were entered for the stepwise regression analysis, which consisted of demographic variables (age, gender, respondents' vocational status, and the setting in which they took the e-learning course), the respondent's backgrounds in e-learning (computer competency, course topics, prior experience with e-learning, time spent in taking the e-learning course, and the amount of interaction with an instructor or technical support staff in the self-directed e-learning course), and the three motivational factors identified from the factor analysis.

The results of this multiple regression analysis revealed that five out of thirteen variables entered for the stepwise multiple regression analysis significantly contributed to predicting the learner's motivational change during self-directed e-learning. Those five predictors accounted for 30.2 percent of the variance in the learner's motivational change (R^2 = .302, adjusted R^2 = .293). Table 5 summarizes the results of stepwise regression analysis, including regression coefficients, intercept, R^2 and adjusted R^2.

Table 5. Results of Stepwise Multiple Regression Analysis of Variables for Predicting the Learner's Motivational Change during Self-Directed e-Learning

	Unstandardized Coefficients		Standardized Coefficients				
Variables §	*B*	*SE B*	β	Intercept	R^2	Adjusted R^2	*R*
1	.988	.098	.467	-.596	.218	.216	.467 **
2	.147	.044	.166	-.592	.241	.236	.491 **
3	.162	.044	.171	-.667	.268	.262	.518 **
4	-.136	.041	-.146	-.442	.289	.282	.538 **
5	.232	.090	.116	-.488	.302	.293	.550 **

Note. Formal education setting was the reference category for educational setting dummy variable, where the other category in this variable was corporate training setting.
** $p < .01$.
§ 1 = Motivational factor: "e-learning is right for me"
2 = Learner satisfaction
3 = Frequency of interaction with instructor or technical support staff
4 = Age
5 = Educational setting.

Furthermore, the results indicated that the first predictor (motivational factor) best explained the variability in the dependent variable, accounting for 22% of the variance (R^2 = .218, adjusted R^2 = .216). The second predictor (learner satisfaction) added 2.3% to the prediction [R = .491, F (2, 363) = 57.527, $p < .01$] and 2.8% of the variance was increased by adding the third predictor (the frequency of interaction with an instructor or technical support staff) to the equation [R = .518, F (3, 362) = 44.258, $p < .01$]. The fourth predictor (age) added 2.1% to predicting the variance [R = .538, F (4, 361) = 36.760, $p < .01$], and the fifth predictor (educational setting) increased the prediction by 1.3% [R = .550, F (5, 360) = 31.193, $p < .01$]. Additionally, the standardized regression coefficients (β) presented in Table 5 show that the fourth predictor (age) has a negative coefficient value whereas the other four predictors has positive coefficients values, indicating a negative linear regression between the learner's age and his or her motivational change.

Discussion and Conclusion

The results of the present study have confirmed other research findings that learners' motivational levels tend to change over time. Given the findings from this study that some learners experience a change in their motivational level during self-directed e-learning, there are clear implications for designing motivating self-directed e-learning environments. By understanding what is associated with the learner's motivational change during self-directed e-

learning, e-learning designers can be better informed on how to create a learning environment in which the learner is expected to sustain his or her motivation to learn during the self-directed e-learning process.

Although e-learning designers cannot control some of the factors that were found to contribute significantly to predicting the learner's motivational change during self-directed e-learning, such as age and educational setting, they can indeed take other significant predictors into account when designing the learning environment to help learners stay motivated. Findings of this study suggest that the learner's motivational level is likely to increase when the e-learning course is designed in a way that is relevant to the learner, has multimedia components and hands-on activities, simulates real-world situations, provides feedback on the learner's performance, and provides easy navigation on its course Web site.

Furthermore, the findings of the present study indicate that in order for motivation to remain constant or increase, the e-learning environment should be designed in a way that makes the learner satisfied with the overall learning experience and that provides him or her with opportunities to interact with an instructor or support staff. Interactions between the learner and instructor or technical staff need to be considered especially when the e-learning courses are designed or delivered for students in college or university settings, because such interactions are more likely to positively influence the motivation in these learners than in learners in workplace settings.

The findings from the present study have implications for the motivational design of self-directed e-learning courses. The nine factors that were found significantly associated with learner's motivational change from the results of the present study can be translated into the principles for the design of motivating self-directed e-learning courses. Figure 2 summarizes the instructional design principles recommended for sustaining the learner's motivation in self-directed e-learning identified from the results of the present study.

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1. Provide learners with content that is relevant and useful to them.
2. Include multimedia presentations in the course that stimulate the learner's interest.
3. Include learning activities that simulate real-world situations.
4. Provide learners with content that the difficulty level of which is just right for them.
5. Provide learners with hands-on activities that engage them in learning.
6. Provide learners with enough feedback on their performance.
7. Design the Web site that is easy to navigate.
8. Design the course in a way that the learner is satisfied with the overall learning experience.
9. Incorporate some social interactions in the learning process (e.g., interaction with instructor, technical support staff, or animated pedagogical agents).

Figure 2. Instructional Design Principles Recommended for Sustaining the Learner's Motivation in Self-Directed e-Learning

It should be acknowledged that there are some limitations to this study. Since this study examined the self-directed e-learning course format, it is likely that the findings of this study might be limited to this particular type of online learning environment. Therefore, readers should take caution not to generalize the findings of the present study to other types of online learning environments (e.g., instructor-led online courses). Additionally, the present study focused on adult learners (e.g., adult students and working adults); it is possible that the motivational needs of adult learners might be different from those of school children or younger adults, as suggested by several theorists and researchers (Bohlin & Milheim, 1994; Gibbons & Wentworth, 2001; Wolcott & Burnham, 1991). Therefore, the findings of the present study may not be generalizable to learners of younger ages.

It is possible that different factors might influence learner motivation in different types of online learning environments. Since this study was conducted with learners who took a particular type of online course, it is recommended that studies are conducted on what influences the motivation of learners in other types of online learning environments (e.g., instructor-led e-learning courses, and online courses in formal education settings). I suspect that such studies will reveal some motivational factors that were not found in the present study but have significant impacts in other online learning environments, and will also provide insights on whether the findings of the present study can be generalized to other types of online learning environments.

I also recommend that factors that influence the learner's attrition from the e-learning course be investigated in future research studies. Investigation of the factors that influenced learner attrition was not attempted in the present study as it was not the main focus of the study. But I believe that such a study will be beneficial in informing educators and instructional designers on how to design self-directed e-learning environments that foster the learner's motivation to persist in learning. Some studies have been done in Web-based distance education programs (e.g., Groleau, 2004; Tello, 2002), yet such research studies are lacking on self-directed e-learning settings. Findings from such a study may provide one with an empirical basis upon which he or she can understand what factors prevent learners from persisting in self-directed e-learning courses.

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Perils of "Teacher-proof" Online Design: Study Findings from Science Web-based Inquiry Activities

Violet A. Kulo
Ward Mitchell Cates
Lehigh University

Having students become competent thinkers has long been an educational goal. Nickerson (1989) noted that many educators agree that we must help students learn to solve problems and think independently, creatively, and effectively (see also Bransford, Goldman, & Vye, 1991; Chipman & Segal, 1985; Resnick, 1987; Resnick & Klopfer, 1989). Bransford, Sherwood, Hasselbring, Kinzer, and Williams (1990) argued the basic problem is traditional instruction does not produce transfer to new problem-solving situations, while Bransford and Vye (1989) further contended that, "many traditional approaches to instruction do not help students make the transition from "knowing that" something is true to "knowing how" to think, learn, and solve problems" (p. 193). Studies in science education reveal that teachers depend heavily on textbooks in shaping their science curricula and instructional choices (Driscoll, Moallem, Dick, & Kirby, 1994; Kesidou & Roseman, 2002; Mitman, Mergendoller, & St. Claire, 1987; Weiss, Banilower, McMahon, & Smith, 2001; Yore, 1991). In 1989, the American Association for the Advancement of Science (AAAS) indicted textbooks, saying,

> The present science textbooks and methods of instruction …. emphasize learning of answers more than the exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understandings in context, recitation over argument, reading in lieu of doing. (p. 14)

In subsequent years, publishers have worked hard to improve textbooks and their accompanying teacher's editions. Teacher's editions provide scaffolds for learning to think pedagogically about particular content (Ball & Feiman-Nemser, 1988). These scaffolds are wrapped around the student pages right where the teacher needs them. The scaffolds provide comprehensive suggestions and activities that are designed to help teachers promote student learning, for example, lesson objectives, instructional strategies, common student misconceptions, specific questions, discussion topics, enrichment activities, and additional resources (Stodolsky, 1999; Woodward & Elliott, 1990).

Yet, according to the National Research Council (2000), traditional textbooks are not conducive to inquiry-based teaching. Calls for restructuring the way students learn in science recommend students be actively engaged in inquiries. Teaching and learning science by inquiry is the central tenet of the *Benchmarks for Science Literacy* (AAAS, 1993) and the *National Science Education Standards* (National Research Council [NRC], 1996). Hoffman (1997) suggested it might be possible, however, to use supplementary materials on the Web (see also NRC, 2000). In an attempt to investigate the extent to which the Web offers scientific inquiries for students, Bodzin, Cates, and Vollmer (2001) examined science sites drawn from The Eisenhower National Clearinghouse (ENC) Digital Dozen award list. Out of 209 award-winning science sites, they found only 19 sites (9.1%) contained inquiry activities. A subsequent study of 137 science sites found only 6 sites (4.4%) contained inquiry activities (Shive, Bodzin, & Cates, 2004). According to Bodzin and Cates (2001), an activity must meet six criteria for it to qualify as a Web-based inquiry (WBI) activity:

1. A WBI must contain at least the first three essential features of classroom inquiry described in *Inquiry and the National Science Education Standards* (NRC, 2000):
   - Learners are engaged by scientifically oriented questions that may be stated implicitly or may be implied as a task.
   - Learners give priority to evidence, which allows them to draw conclusions and/or develop and evaluate explanations that address scientifically oriented questions.
   - Learners draw conclusions and/or formulate explanations from evidence to address scientifically oriented questions.
2. The WBI must be learner-directed. The WBI should be phrased in such a way that learners would perceive it as directed at them. The majority of the wording used in the WBI should be directed at the learner ("you"), not at the teacher ("your students").
3. The WBI must support student learning of a science concept or content. Science WBIs must fall into a recognized science discipline (biology, chemistry, physics, environmental sciences, astronomy, oceanography and the like).

4. The WBI must be Web-based. A WBI is more than printed material placed on the Web, describing how an inquiry activity may be completed. Instead, it should go beyond simply being reformatted text from a printed sheet. It should be enhanced or customized to take advantage of the features of the Web to deliver instruction.
5. Evidence used in a WBI should be of the same type an actual scientist would use.
6. Conclusions and/or explanations must involve reasoning. They should be more than simple data analysis and reporting.

These criteria focus almost exclusively on how WBIs meet student needs. Colburn (2000) contended, however, that the teacher is the key element in a successful inquiry-based classroom (see also Joyce, Weil, & Showers, 1992). In fact, the National Research Council (1996) states under *Teaching Standard B* that, "at all stages of inquiry, the teacher must guide, focus, challenge, and encourage student learning" (p. 33). If WBIs focus on students only, they might be mistaken for being a form of "teacher-proof" materials. According to Tanner and Tanner (1975), "teacher-proof" materials are somewhat resistant to teacher tampering or to variations in individual teacher's style, orientation, or competence, while Schubert, Schubert, Thomas, and Carroll (2002) defined "teacher-proof" materials as, "materials that would achieve goals without distortion by teacher implementation" (p. 149). Pratt (1980) argued that in the 1960s designers of certain curricula decided teachers were not competent to teach the content. They developed curriculum materials that required little or no teacher intervention. Both content and methodology were packaged and accompanied by elaborate implementation instructions for teachers to follow (Schubert, 1986). The use of those materials did not, however, yield expected results in terms of increasing student achievement (Schubert, 1986; Tobin & Dawson, 1992).

Much literature exists on the role teachers play in supporting student learning. Wright, Horn, and Sanders (1997) concluded the most important factor affecting student learning is the teacher (see also Brophy, 1986; Darling-Hammond & Bransford, 2005). Flick (1998) agreed and argued that, while a computer, textbook, or laboratory materials may serve as proxy for a "teacher," the most important source of scaffolding in a classroom is the flesh-and-blood teacher (see also Krajcik, Blumenfeld, Marx, & Soloway, 2000; McKenzie, 2003). Crawford (2000) suggested inquiry-based teaching requires greater levels of involvement by teachers than in traditional teaching. In addition to the roles for the science teacher as motivator, diagnostician, guide, innovator, experimenter, and researcher articulated by Osborne and Freyberg (1985), Crawford proposed new roles that require more active and complex participation than simply being a facilitator or guide. Those roles are modeler, mentor, collaborator, and learner. Teachers, thus, make a difference and play an important role in making learning work. Soloway (1996) asserted that "teacher-proof curriculum is a silly, hostile notion, as is the idea that computer-based tutorials can replace teachers" (p. 11).

According to Zion and Slezak (2005), the interaction of the self-directed student and the facilitating teacher promotes the inquiry process. Teachers, therefore, need to be knowledgeable in inquiry-based methods for students to understand inquiry. The National Research Council (2000) noted that most teachers have not had opportunities to learn science through inquiry or to conduct scientific inquiries themselves. A national survey of science and mathematics education found that 60% of K-12 science teachers reported they perceived a need for professional development in learning to use inquiry/investigation-oriented teaching strategies (Weiss, Banilower, McMahon, & Smith, 2001). Further, teachers implementing inquiry-oriented learning environments often lack appropriate and adequate instructional materials, both print and hands-on (NRC, 2000). Hammer (2000) posited that, to promote student inquiry, we must do more to understand and support teacher inquiry. As noted earlier, textbook publishers attempt to provide support for teachers through the scaffolds provided in the teacher's edition.

Project 2061, a science reform initiative of the American Association for the Advancement of Science (AAAS) developed a conceptual framework for analyzing how well science curriculum, instruction, and assessment help students achieve specific learning goals. That framework analyzes the extent to which a material's content aligns with student learning goals; the extent to which the material's instructional strategies support attainment of the specified learning goals; and the extent to which the material's accompanying teacher's edition supports teachers in helping students attain those specified learning goals (AAAS, 2000). Although the AAAS framework was designed for use in analyzing textbooks, we conjectured its instructional support criteria might be used to guide teachers in the selection of appropriate WBIs that will enable them to help students in achieving national benchmarks.

Purpose of the Study

This study examined science WBIs to determine how well their features map to the AAAS instructional support framework. It sought to answer two questions: 1) What AAAS instructional support strategies are currently being employed in science WBIs and, 2) How well are those strategies being employed?

Methodology

Research Design

This was a mixed methods study. Given the two questions, we employed content analysis (qualitative) and descriptive statistical analysis (quantitative). Content analysis makes "replicable and valid inferences from data to their context" (Krippendorff, 1980, p. 21). We chose this design because capturing data in their context is useful for identifying what exists and the way it manifests itself (Ritchie, 2003). According to Weber (1985), the best content analytic studies utilize both quantitative and qualitative methods. Miles and Huberman (1994) agreed and noted that during analysis of qualitative data, quantitative data can help to generalize specific observations, and one way this can be done is by "quantizing"; that is, counting qualitative information directly. Thus, we also used descriptive statistics to summarize and describe the data (Ary, Jacobs & Razavieh, 1990).

Population and Sample

We selected the 25 sites that had previously been validated by Bodzin and his colleagues as containing science Web-based inquiry activities as our population. They found 34 inquiry activities across 19 sites in the first study and 17 inquiry activities across six sites in the second study, yielding a population of 51 WBIs. We found one site had been duplicated across the two studies, six sites (12%) were no longer available or their locations had changed without redirecting us, and three sites were not science WBIs according to Bodzin and Cates' (2001) qualifying criterion three. The non-science sites were mathematics and navigation, social studies, and language arts. This yielded a sample of 41 WBIs.

Instrumentation

To justify inferences, a content analyst must use an analytical construct that serves as the logical bridge between data and their context (Krippendorff, 1980). Using the AAAS instructional support framework as our analytical construct, we created an instrument that mapped observed functions and features of each WBI to identified AAAS strategies for enhancing student learning. The first two columns of the instrument contained AAAS strategies of instructional support. We added three columns: the first in which we mapped the observed feature to an identified AAAS strategy, the second in which we wrote the feature's exact location (URL), and the third in which we wrote comments or analytical insights.

Procedure

A key issue in content analysis is validity. We randomly selected five sites using the www.random.org random number service. We tested the instrument through independent analysis of those five initial sites, using it to analyze how each previously validated WBI met the AAAS strategies for instructional support. Unfortunately, the initial AAAS instrument we used had criteria but no indicators of how to determine if something met those criteria. As a result, we had difficulty agreeing on how to rate the WBIs. Fortunately, the first author found another version of the AAAS instructional support framework whose criteria were further broken down into indicators that provided more guidance on how to analyze (AAAS, 2002).

Using the new instrument, we reanalyzed our initial five sites. We discovered we still did not agree on all ratings and this necessitated discussion and resolution of our differences, including reanalysis of sites. We continued this interactive process until we agreed on our ratings and then the first author analyzed the entire set of 41 sites.

Holsti (1969) emphasized that content analysis requires objectivity; that is, the analyst must use explicitly formulated procedures that minimize the possibility the findings reflect his or her subjective bias rather than the content under analysis. To confirm the objectivity of the first author's ratings, we randomly selected five additional sites and analyzed them for inter-rater validation. Over several meetings, we met to compare results of our analysis, once again discussing differences, formulating rules to guide us, and reanalyzing until we were in agreement on all five sites. Following each of our interactive validation sessions, the first author re-examined all 41 sites to make sure her ratings continued to align with our validation discussions. Thus, in a total of 11 hours, we employed the multi-pass unanimous consensus technique described by Bodzin et al. (2001).

Findings

To identify what AAAS strategies were employed in the sample sites and how well they were employed, we tabulated the frequency of each strategy. A summary of how the AAAS strategies were implemented across the sample sites is shown in Table 1. Strategies with a stronger implementation were employed in more than half of the sample sites; strategies with a moderate implementation were employed in at least half of the sample sites; strategies with a weaker implementation were employed in one quarter or less of the sample sites; and some strategies were not implemented at all.

Table 1. Percentage of Strategies Implemented across Sample

Status of Implementation		**# of Strategies**	**% of 74**
Stronger Implementation	(51%-100%)	25	34%
Moderate Implementation	(26%-50%)	16	22%
Weaker Implementation	(1%-25%)	24	32%
Not Implemented	(0)	9	12%

We counted the total number of AAAS strategies employed in individual WBIs and found they ranged between 15 and 44 strategies; that is, the site with the weakest implementation employed 15 strategies (20%) and the site with the strongest implementation employed 44 strategies (59%). Times to completion of examined WBIs varied. We completed the shortest activity (http://whale.wheelock.edu/whalenet-stuff/Blubberglove.html) in about half an hour while the longer activities, for example, http://arcytech.org/java/population/ took approximately two-and-a-half to three hours to complete. We clustered our findings around six key concepts or practices:

Concept: Learner Engagement

This refers to whether the sites presented interesting and/or motivating activities to engage students. We found not all activities were engaging. For instance, the *Probing your Surroundings* activity (http://wise.berkeley.edu/student/topFrame.php?projectID=5358) involved measuring the temperature of objects around the classroom. That activity seems commonplace and unlikely to engage most students. Some sites pretended to present activities about bigger issues. For example, the description of the *Keeping an Eye on Ozone* activity (http://pathfinderscience.net/ozone/index.cfm) was about how ground-level ozone can affect the respiratory system and is harmful to very young and elderly people and those people with chronic lung disease. Yet the activity involved measuring the level of ground-level ozone and its effect on common milkweed leaves. Other activities seem likely to have little personal relevance to most students. For instance, while the *Malaria Introduction* activity (http://wise.berkeley.edu/student/topFrame.php?projectID=4439) may appeal to students who live in places with tropical climates where the problem is prevalent (like Africa and South America), that same activity may not be equally interesting and/or motivating to students who live in cold areas (like Wyoming or North Dakota) where malaria is not a problem. Conversely, urban sprawl and AIDS are universal and relevant problems and so the *Sprawl in the Lehigh River Watershed* activity (http://www.leo.lehigh.edu/envirosci/enviroissue/sprawl/index.html) may appeal to a wide range of students regardless of their location.

Concept: On-going Learning

This refers to whether the sites connected instruction across activities. We found the examined WBIs existed in isolation as single activities; they were not presented in a scaffolded sequence that would ensure on-going learning. Activities consisted mainly of filling out worksheets, data collection and submission, doing experiments, filling out journals, debates, and online discussions. Activities that involve experiments or data collection and submission do not lend themselves well to being in a scaffolded sequence because once the step-by-step experiment is complete or the data are submitted, that marks the end of the activity. Activities that involve debates, online discussions, filling out journals, however, *routinely* encourage students to express their ideas.

Concept: Learning over Time

It appears AAAS intended for learning to be spaced out over time. Support for this is evident in their use of words that imply a timed learning sequence such as *routinely, sequences, periodically, infrequently,* and *consistently.* We found not all activities were spaced out to allow for a timed learning sequence. Spaced activities relate individual activities to one another in which students and teachers behave consistently in specified ways. For instance, most of the *CIESE* WBIs which make up 15% of the sample sites have students collect data, fill out worksheets, and collaborate with peers and experts. Teachers, on the other hand, are expected to facilitate implementation of those inquiries and assess students. Ten sites (24%) had one activity each and would likely be completed in one class period. Fourteen sites (34%) had multiple activities, while 17 sites (42%) had one activity

each that required students to collect data or do an experiment over a period of days. Thus, approximately three quarters of the WBIs examined appeared likely to take more than one class period to complete and would have provided opportunities for students to conduct them over a period of time.

Concept: Task Novelty

This refers to whether the sites included novel tasks and assessment to judge transfer of what has been learned. We had trouble interpreting what AAAS means by *novel*. One way to define *novel* is non-traditional; that is, activities that are not commonly done in the "traditional" classroom. We found activities designed with the same model had the same nature of tasks and assessment. For instance, activities designed with the *CIESE* model involved filling out worksheets and collecting data; activities designed with the *WISE* model involved, among others, online discussions and filling out journals; the *Carolina Coastal Science* activities presented resources on different problems for students to explore, choose a stakeholder position, and debate on how they would vote on those problems while justifying their position; the *PathFinder Science* activities involved doing experiments, collecting and submitting data. If one would classify filling out worksheets, doing experiments, filling out journals, collecting and submitting data as activities commonly done in the "traditional" classroom then they would not qualify as *novel*. Twenty-nine sites (71%) contained activities that were not *novel*, whereas 12 sites (29%) contained *novel* activities such as debates and online discussions.

Practice: Addressed Prerequisites

This refers to whether the sites adequately addressed prerequisite ideas and skills, and made adequate connections between specific ideas and their prerequisites. In the classroom, teachers often help learners to recall prerequisites and they make clear how those prerequisites connect to the next lesson. We found most WBIs stand alone and are not presented in a unit that contains related activities in which connections between ideas and their prerequisites can be made. Some WBIs presented background information on the activities which seemed to be content related to the topic under study but did not provide adequate prerequisite knowledge and skills that learners would need to conduct the inquiries.

Practice: Support for Teachers

The American Association for the Advancement of Science intended for materials to provide a lot of support for teachers but we found most sites had little support for teachers and some sites did not provide any support at all. Table 2 presents the distribution of teacher-support strategies across the sample sites. Twenty-four sites (59%) across the sample had teacher sections. The 19 teacher-support strategies in Table 2 were employed in less than half of the sample sites. The teacher-support strategy that was employed the most in 18 sites was recommending resources for enrichment activities and for improving the teacher's understanding of key ideas.

Table 2. Percent of Teacher Support Strategies across Sample

Strategies	# WBIs Found	% of 41
Recommend resources	18	44%
Assist in identifying students' ideas	13	32%
Suggest encouraging students' questions	12	29%
Suggest engaging students monitor change in ideas	8	20%
Provide sufficiently detailed answers	8	20%
Provide specific feedback	6	15%
Alert to prerequisites	5	12%
Interpret responses	3	7%
Alert to specific ideas for which prerequisites needed	2	5%
Alert to commonly held student ideas	2	5%
Instruct to carry out expected performance	1	2%
Alert to how ideas have been simplified	1	2%
Probe beneath initial responses	0	0
Suggest taking into account own students' ideas	0	0
Diagnose student errors	0	0
Suggest using assessment for instructional decisions	0	0
Provide interaction examples	0	0
Modify activities	0	0
Validate students' experiences	0	0

In the classroom, teachers tend to recommend additional resources after the lesson to help learners further their understanding. Other interactions such as addressing common student misconceptions, diagnosing student errors, providing feedback, interpreting responses, probing students' ideas, and elaborating concepts are likely to be done during the lesson. Those scaffolds that are likely to help the teacher during the inquiry process were not as well implemented as recommending enrichment activities which the teacher would, ideally, need after students conduct the core activity. It is worth noting that out of the nine instructional support strategies that were not implemented at all in any of the sample sites, seven were teacher-support strategies. Kinnaman (1993) asserted that far too much effort still goes into trying to make technology "teacher-proof"; yet, technology possesses no inherent philosophy of education, nor can it independently participate in the art of teaching.

Discussion

We found that 6 sites of the 50 previously validated WBIs (12%) were no longer available or their locations had changed without redirecting us. It is unclear why one out of eight sites has disappeared but one might conjecture that some sites may have lost the funding that supported them. It is also possible that the attrition may be due to limited staff to maintain the sites. Of the examined WBIs, 24 sites (59%) are hosted on university, college, or high school Web sites; 15 sites (37%) are designed and sponsored by science organizations; one site (2%) is maintained by a government organization; and one site (2%) named a single individual as the creator of the site. Universities, colleges, schools, government organizations, and science organizations are more likely to be continually funded and so WBIs supported and maintained by those institutions may be more likely to continue to exist.

This study found that not all activities were engaging. Harmer and Cates (in press) suggested students will engage with inquiry if they feel they are contributing to solving a real, local, and relevant problem. Harmer and Cates illustrated the student's sense of the relevance of the problem with a *Hierarchy of Empowerment,* from the lowest sense of personal relevance to the highest sense of the value of deriving a solution. It might be challenging for the people designing WBIs to customize them for personal relevance since activities on the World Wide Web are by nature available globally. Any one of the WBIs may be local and relevant for one group of students and not another, depending on where the students are located. A few sites pretended to have greater significance than it appears the activity warranted. This might be an acknowledgement by designers that learners need to engage with inquiry, and telling them upfront the problem is important might engage them. While this might create initial interest, learners are likely to disengage once they realize the true importance of the inquiry.

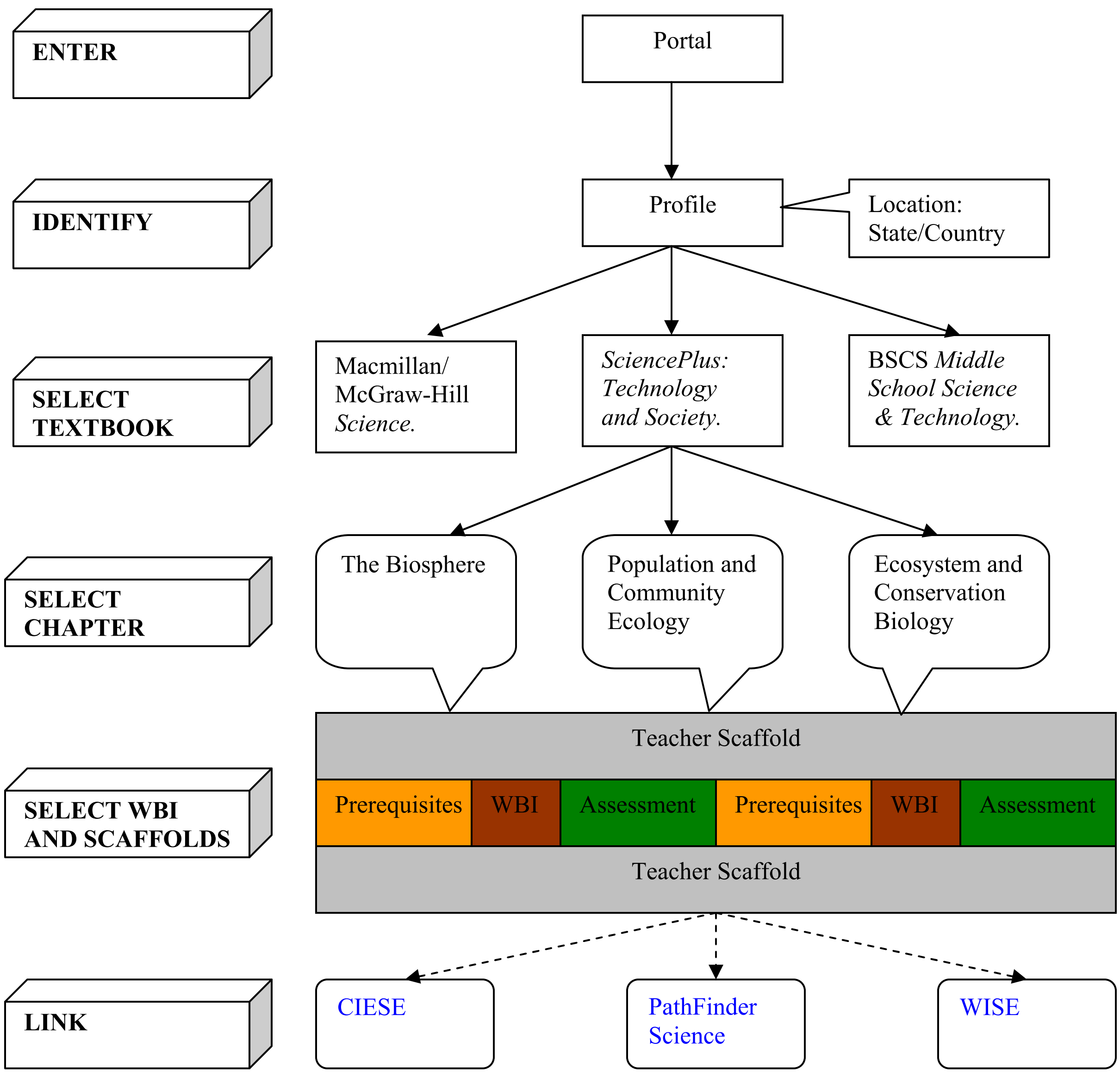
Although standalone WBIs may be useful, they may not meet AAAS criteria for instructional support. The reason for the lack of a scaffolded sequence may be due to the fact that the sample sites exist in isolation; they are not integrated in a curriculum and so instruction is not connected. Textbooks publishers often correlate the content, scope, and sequence in textbooks with published curricula of states and school districts (Squire & Morgan, 1990). In contrast, WBIs tend to be developed as standalones, perhaps by science organizations, professors, teachers, and scientists who have interest in a particular content or topic. Clearly, single activities do not lend themselves well to a scaffolded sequence since a sequence requires more than one activity. Even if existing WBIs could be put in a scaffolded sequence, someone would need to create that sequence. Historically, no organization to do such sequencing has existed.

Teachers have not been well addressed in examined WBIs, certainly not to the extend AAAS believes they need to be. Support for teachers across the examined sites was usually background information related to the topic or non-scaffolded enrichment activities. There could be several reasons for this. First, WBIs may not be focused on teachers because they are learner-directed, which is criterion two an activity must meet for it to qualify as a WBI (Bodzin & Cates, 2001). Second, designers of WBIs may be talented at conducting inquiries but may not realize they need to instruct teachers what to do. Bodzin and his colleagues might have gotten half of the picture of what currently exists because they focused on the extent to which the Web offers scientific inquiries for students. They did not focus on the whole inquiry process but on the form such inquiries take. It might be possible that since all three of the designers of the original WBIs criteria (Bodzin, Cates, & Vollmer, 2001) are experienced teachers and have experience with inquiries, they may have assumed teachers know what to do and thought there is no need to tell them what to do. This could be a blind spot for designers who might assume that users of instructional materials will know what to do. Third, it may be challenging for designers to design scaffolding. Inquiry produces different results; it does not have a repeated experience. Designers may, therefore, have difficulty anticipating what students need because those needs may be unpredictable.

Recommendations

To address the problem of attrition and help keep sites alive, one might be able to create a central site, for example, a clearinghouse that would house new WBIs and link to existing ones. Another role of the clearinghouse would be to improve and consolidate WBIs to fit into a larger context. An illustration of the logic of that central site is presented in Figure 1. The columns on the left of the illustration denote the process one would use to select a WBI. Users would enter the site by logging in through the portal and identify their location to bring up activities that are real, local, and relevant to them. That would solve the problem of learner engagement since users would be able to select problems that are local and relevant to them. The clearinghouse could integrate WBIs in the standard curriculum driven by national benchmarks and standards by mapping a list of all AAAS informed WBIs to popular textbooks. The clearinghouse could cluster WBIs contextually and put them in a scaffolded sequence in which prerequisites of each activity are connected to the assessment of the preceding activity. That would help address the problem of on-going learning. The clearinghouse could build scaffolds around WBIs to help solve the problem of lack of support for teachers. Users would select the desired textbook, chapter, and a WBI with its associated scaffolds. The clearinghouse could develop an instructional model with guidelines like the model used in *Web-based Inquiry Science Environment (WISE)* or *PathFinder Science* activities. The clearinghouse would validate a site if it had all components of the model and then would recognize it publicly.

Figure 1. Illustration of the Logic of Suggested Clearinghouse



But such a clearinghouse would require staff and funding. One way the clearinghouse could be funded would be by a seed grant from the National Science Foundation or a similar agency. Another option might be that textbook publishers could underwrite the clearinghouse and be able to link to it from their Web sites. It could be staffed with multiple experts like curriculum designers, teachers, instructional designers, and Web designers to design new WBIs and link to existing ones. The clearinghouse could also build a community of practice where teachers discuss classroom practice and share their own experiences, techniques and approaches to the inquiry process. In addition, it may be possible to map those WBIs to higher education textbooks. This would help pre-service science teachers learn science through inquiry and, thus, address the problem of most teachers not knowing how to conduct scientific inquiries.

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A Comparison of Individually versus Collaboratively Generated Computer-based Concept Mapping

So Young Kwon, Ph.D.
Lauren Cifuentes, Ph.D.
Texas A&M University

Abstract

Using a quasi-experimental design the researchers investigated the comparative effects of individually-generated and collaboratively-generated computer-based concept mapping on middle school science concept learning. One hundred sixty-one students (74 boys and 87 girls) in eight, seventh grade science classes at a middle school completed the entire study. Qualitative data were analyzed to explain quantitative findings. The researchers concluded that the concept mapping software, Inspiration™, fostered construction of students' concept maps individually or collaboratively for science learning and helped students capture their evolving creative ideas and organize them for meaningful learning.

Introduction

According to Novak (1998), concept mapping is a process of organizing and representing concepts and their relationships in visual form. Concept mapping is one tool that can overtly engage students in meaningful learning processes. Further, concept mapping promotes meaningful learning and retention of knowledge for long periods of time and helps students negotiate meaning (Hyerle, 2000; Novak, 1990).

McKenzie (1998) said that graphic organizers such as concept maps or thinking maps allow students to convert complex and messy information into meaningful displays. A variety of research studies have demonstrated the positive value of using concept mapping in the science classroom (Boujaoude & Attieh, 2003; Boxtel, van der Linden, Roelofs, & Erkens, 2002; Fischer, Bruhn, Grasel, & Mandl, 2002; Madrazo & Jordi, 2002; Odom & Kelly, 2001; Okebukola & Jegede, 1988; Roth, 1994; Snead & Snead, 2004). Concept maps are a useful science education tool for engaging students' understanding (Jonassen, 2000).

This present study builds on previous research on the effect of the use of visualization during study time (Cifuentes & Hsieh, 2003a, 2003b) and the effect of student constructed visualization using computers as a cognitive tool (Cifuentes & Hsieh, 2004; Hsieh & Cifuentes, 2006). Visual representation facilitates both recall and comprehension (Cifuentes & Hsieh, 2003a, 2003b; Gobert & Clement, 1999; Hsieh & Cifuentes, 2006).

The purpose of this study was to investigate the comparative effects of individually or collaboratively generated computer-based concept mapping on middle school science learning and quality of concept maps. Using a quasi-experimental design, the comparative effect of individually and collaboratively generated computer-based concept mapping on science concept learning was investigated. The researchers asked the following research questions:

1. Do middle school students who collaboratively or individually generate computer-based concept maps perform better on a comprehension test than those who do not generate computer-based concept maps?
2. Do middle school students who collaboratively generate computer-based concept maps perform better on a comprehension test than those who individually generate computer-based concept maps?
3. Will the quality of concept maps generated collaboratively exceed the quality of concept maps generated individually?

Additionally, answers to the following questions will help explain results:

4. How did students' attitudes toward generating concept maps during study time differ across the individually-generated concept mapping group and the collaboratively-generated concept mapping group?
5. What specific learning strategies were used in each group to prepare for the test and did they differ according to group?

Method

A non-randomized, control-treatment group, post-test only, quasi-experimental design was used to investigate the relative effect of individually or collaboratively generated computer-based concept mapping on 7th

grade science concept learning. Using both quantitative and qualitative methods helped triangulate results from diverse data sources.

Participants

One hundred and sixty one students (74 boys and 87 girls) in eight 7th grade science classes at a middle school completed the entire study. Using prior science performance scores to assure equivalence of student achievement across groups, the researchers assigned the teacher's classes to one of the three experimental groups. The three experimental groups were equivalent across students' academic performance and prior knowledge of science content.

Design, Procedures, and Instruments

The independent variables were gender and treatment group. The treatment group consisted of three levels: the control group of 40 students, 59 students trained to individually generate concept maps on computers, and 62 students trained to collaboratively generate concept maps on computers. The dependent variables were science concept learning as demonstrated by comprehension test scores and quality of concept maps as demonstrated by rubric scores.

Computer-Based Concept Mapping Workshop Training

Both experimental groups (individual and collaborative) that created concept maps on computers while studying the science concepts attended three days of workshops on computer-based concept mapping of science concepts on computers in their computer laboratory before starting to study science concepts. These topics were not related to topics tested after experimental treatments.

Instructional Format of Treatment Across Groups

The control group, the individually-generated concept mapping group, and the collaboratively-generated concept mapping group had equivalent learning experiences for fifty minutes during five days, except that students in the control group worked independently without being told to apply a particular study strategy, students in the individual group worked individually to construct concept maps, and students in the collaborative group worked collaboratively to construct concept maps during their study time. Students in the individual and collaborative experimental groups first learned how to develop concept maps on computers using Inspiration™, were then given science concepts to study using concept mapping, and were then tested on those concepts.

The comprehension test.

The comprehension test consisted of fifty paper-and-pencil based multiple-choice items from the Glencoe Science/ Texas Science for 7th grade textbook (Biggs, Feather, Snyder, & Zike, 2002) that was provided with the seventh grade textbook adopted by the participating school district (r=.86). Items were criterion referenced to concepts that students studied during their experimental study time.

Learning strategy questionnaire and computer use survey.

All participants were asked to fill out a "Learning Strategy Questionnaire" in the last minutes of the fifth day. The "Learning Strategy Questionnaire" is a student self-report instrument developed by the researcher. Students were asked to determine whether or not they had been exposed to the reading content prior to studying. Also, students were asked to explain how they felt about making concept maps that show interrelationships among concepts during study time and discuss how making concept maps helped them learn content. All students completed the "Computer Use Survey" administered to investigate students' use of computers at school and at home as well as the frequency of using computers to support a number of purposeful tasks.

Rubric for assessing the quality of concept maps.

Concept maps generated by students individually and collaboratively during five days of treatment and testing were analyzed for quality by three reviewers (two teachers and one researcher). Concept maps were scored according to the four scoring components created by Novak and Gowin (1984). Reliability was established by obtaining three independent scores on each concept map. Three reviewers independently scored students' concept maps as the final products of the five day experiment based on the rubric formula created by Novak and Gowin (1984). Inter-rater reliability was computed by determining the correlation between three reviewers and scoring for each concept map. The inter-rater reliability correlations between reviewer A and B, A and C, and B and C using Pearson's Correlation were .97**, .98**, and.98**, indicating significant correlations at the 0.01 level.

Data Sources

Data sources included (a) students' comprehension test scores, (b) students' responses to the "Learning Strategy Questionnaire," (c) students' responses to the "Computer Use Survey," (d) rubric scores for assessing the quality of concept maps, (e) students' study notes, (f) students' concept maps, and (g) the researcher's reflective journal that documents observations of students' learning behaviors during the workshop and experiment.

Results

Results of data analyses provided answers to the research questions regarding the effect of individually or collaboratively generating concept maps on comprehension, effects of individually or collaboratively generating concept maps on quality of concept maps, students' attitudes toward generating concept maps, and learning strategies used by students across groups.

Effects of Individually or Collaboratively Generating Concept Maps on Comprehension

An one-way analysis of variance (ANOVA) applied using treatment group as the independent variable and comprehension test scores as the dependent variable revealed that means differed across groups (see Table 1). The two experimental groups' mean scores were respectively: individual group (n = 59, mean = 29.10, SD = 8.85), and collaborative group (n = 62, mean = 31.39, SD = 8.46). The control group (n = 40) yielded a significantly lower mean score of 19.13 (SD = 8.24) than the two experimental groups.

The assumption of equal variance (Levene's Test of Equality of Error Variances) was tested and groups were found to be homogenous (F = .18, p = .83). Therefore, the data satisfied ANOVA assumptions. In addition, the assumption of normality (Shapiro-Walks Test of Normality) was met (S-W= 1.99, p = .86). Therefore, non-parametric tests were not necessary.

Table 1

Summary Statistics on Comprehension Posttest Scores

Summary Indications	Collaborative Group	Individual Group	Control Group
Minimum	5.00	4.00	0.00
Quartile 1	26.00	24.00	15.50
Median	30.50	30.00	19.00
Quartile 3	38.00	35.50	25.00
Maximum	49.00	47.00	38.00
Mean	31.39	29.10	19.13
Standard Deviation	8.46	8.85	8.24
Sample Size	62	59	40

The one-way ANOVA results indicated that a significant difference existed among the control, individual, and collaborative groups on the mean scores of the comprehension posttest, F = 26.62 (p < .05.) as seen in Table 2.

Table 2

One Way ANOVA Summery Table for Effects of the Types of Treatment and Comprehension Posttest Scores

Source	Sum of Square	Df	Mean Square	F	Significance
Group	3893.77	2	1946.89	26.63	.00*
Error	11552.48	158	73.12		

*p < .05.

The Tukey Honestly Significant Difference (HSD) post hoc test was performed for group comparison. The Tukey HSD post hoc test revealed that the group that individually generated concept maps (individual group) significantly outscored the group that did not generate concept maps (control group). The group that collaboratively generated concepts maps (collaborative group) significantly outscored the group that did not generate concept maps (control group) in its performance (see Table 3). Cohen's d indicated a positive large effect size (d = 1.17) for the comparison of the individual concept mapping group and the control group as seen in Table 3. Additionally, Cohen's d indicated a positive large effect size (d = 1.47) for the comparison of the collaborative concept mapping group and the control group. The effect size indicated that training students to individually or collaboratively create concept maps on the computer and then encouraging them to generate concept maps while studying had positive effects on middle school students' science concept learning.

Also, students' learning of visualization skills and the generation of concept maps on the computer during study time resulted in a significant positive effect on science concept learning. Therefore, the first research question asking if middle school students who collaboratively or individually generate computer-based concept maps perform better on a comprehension tests than those who do not generate computer-based concept maps was answered affirmatively.

In addition, the Tukey HSD post hoc test revealed that the group that collaboratively generated concepts maps (collaborative group) did not significantly outscore the group that individually generated concept maps (individual group) in its performance. Cohen's *d* only indicated a small effect size (d = 0.27) for the comparison of the individual concept mapping group and the collaborative concept mapping group as seen in Table 3. Although students who generated concept maps on the computer during study time performed significantly better than those who did not, there was no significant difference between the individual and the collaborative groups (Cohen's d = 0.27). Therefore, the second research question asking if middle school students who collaboratively generate computer-based concept maps perform better on a comprehension test than those who individually generate computer-based concept maps was answered negatively according the Tukey HSD post hoc test results.

Table 3
Post Hoc Test Table for the Effects of the Types of Treatment and Comprehension Posttest Scores

Tukey HSD (I) Group	(J) Group	Mean Difference	Sig	Effect Size
Control	Individual	9.98	.00*	Cohen's d = 1.17 r = 0.51
Control	Collaborative	12.26	.00*	Cohen's d = 1.47 r = 0.60
Individual	Collaborative	2.29	.31	Cohen's d = 0.27 r = 0.15

$^*p < .05$.

Effects of Individually or Collaboratively Generating Concept Maps on Quality of Concept Maps

To determine whether or not concept maps generated collaboratively exceed the quality of concept maps generated individually, the one-way analysis of variance (ANOVA) was applied using treatment group as the independent variables and rubric scores for assessing the quality of concept maps as the dependent variable.

The assumption of equal variance (Levene's Test of Equality of Error Variances) was tested and groups were found to be homogenous (F = 3.51, p = .06). Therefore, the data satisfied ANOVA assumptions. In addition, the assumption of normality (Shapiro-Walks Test of Normality) was met (S-W = .98, p = .44). Therefore, non-parametric tests were not necessary.

The analysis revealed that means differed across groups (see Table 4). The mean score on the quality of concept maps for the collaborative group was 141.27 (SD = 30.10), while the individual group yielded a significantly lower score of 108.74 (SD = 40.31).

Table 4
Summary Statistics on Rubric Scores

Summary Indications	Collaborative Group	Individual Group
Minimum	94.70	19.70
Quartile 1	114.05	85.35
Median	143.30	101.10
Quartile 3	157.05	139.25
Maximum	215.80	182.00
Mean	141.27	108.74
Standard Deviation	30.10	40.31
Sample Size	31	59

The one-way ANOVA results indicated that a significant difference existed between the individual and the collaborative groups on the mean scores of the rubric assessing the quality of the concept maps, F = 15.58 (p < .05.), as seen in Table 5. The results revealed that the students who collaboratively generated concept maps significantly

outscored those who individually generated concepts maps in their performance on the quality of concept maps. Cohen's *d* indicated a positive effect size (d = 0.91) for the comparison of the group who collaboratively generated computer-based concept maps and the group who individually generated computer-based concept maps on the quality of concept maps. Therefore, the third research question asking if the quality of concept maps generated collaboratively will exceed the quality of concept maps generated individually was answered affirmatively.

Table 5
One-Way ANOVA Summery Table for Effects of the Types of Treatment and the Rubric Scores for Assessing the Quality of Concept Maps

Source	Sum of Square	Df	Mean Square	F	Significance
Group	21496.63	1	21496.63	15.58	.00*
Error	121419.81	88	1379.77		
Effect Size (individual vs. collaborative): Cohen's d = 0.91					
r = 0.42					

*$p < .05$.

The results of the qualitative analyses conducted to answer the fourth research question indicated that the attitudes toward concept mapping for science concept learning were positive. Most students agreed that concept mapping was a good technique for studying. Both the collaborative group students and the individual group students thought that creating concept maps using the computer program was helpful and useful to study science concepts. Their reasons could be summarized as follows: (a) students said that concept mapping helped them organize information leading to better understanding and the ability to answer questions easily; (b) concept mapping assisted them in memorizing the science concepts and helped them retain the learned concepts to prepare for an exam; and (c) computer assisted concept mapping was a useful technique for adding, deleting, revising and saving concept maps on computers. In summary, creating concept maps using the computer program, Inspiration™, provided students with a useful learning strategy and a positive learning experience.

An interesting finding was that the students in the collaborative group were more positively engaged in their studying than the students in the individual group. Only 52% of the individual group students thought that working by themselves was helpful and useful to study science concepts while 70% of the collaborative group students thought that working with a partner was helpful and useful to study science concepts. According to this finding, the researcher inferred that students' positive attitudes toward collaboration positively influenced the results on the quality of concept maps.

The results of the qualitative analyses indicated that the control group and both experimental groups' students applied different study strategies for science concept learning as follows: The control group students studied using their own rote learning strategies (read, highlight, underline, or memorize) while both computer-based concept mapping groups' students (individual and collaborative) engaged in meaningful learning to study relationships between concepts and links that reflected their own understanding about conceptual science knowledge. This finding explains differences in comprehension between the control group and the concept mapping groups.

Conclusion

When students create concept maps with peers in collaboration, they discover, construct, and become aware of their own cognitive structures by representing and explaining their concepts and ideas. Collaborative learning facilitates divergent ways for learners to think and prompts students to consider different perspectives of a problem. Also, collaborative learning stimulates critical and creative thinking (Stoyanova & Kommers, 2001).

In this study, students who collaboratively generated concept maps in pairs were actively engaged in creating concept maps for science concept learning, and their performance significantly exceeded students who individually generated concept maps on the quality of concept maps. Comparing the individual group and the collaborative group on the quality of concept maps, the collaborative group's concept maps showed more valid propositions and relationships between concepts and links than the individual group's concept maps. The students who created concept maps with pairs made more complex maps that included concepts, subconcepts, and linkages that constructed propositions.

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Technology Integration and Teacher Training: The Effectiveness of Embedding Technology into Education Coursework

Elaine Lawrence, Ph.D.
State University of New York – College at Oneonta

Technological literacy is quickly becoming an educational standard in the classroom. Increasingly, educators are expected to model technological literacy and integrate technology into the curriculum. Teachers who exude confidence in their technological abilities are more likely to integrate technology into the classroom curriculum (Jao, 2001).

Initially, many teacher education programs require pre-service teachers to enroll in an introductory computer science course to obtain training in fundamental computer skills. Maeers (2000) asserts that a single technology course is insufficient training to generate technologically literate teachers with the confidence to integrate technology into the curriculum. For this reason many teacher education schools have been slowly altering their approaches to technology's role within the curriculum. Teacher technology requirements that began as a detached introductory computer course have become either a separate educational technology course incorporating skills training with curriculum integration or have included adding technological aspects to educational methods courses and student teaching experiences (Brown, Appelman, Green, & Hansen, 2000).

With this change in focus the need to study the use of technology as an instructional tool is imperative because of the implicit impact on future classrooms (Kjetsaa, 2002). Future educators are expected to fully implement technology integration into the curriculum while having had only minimal exposure to computer applications via introductory computer science and methods courses that do not allow for recurring practice in using technology to augment K-12 student learning (Beyerbach, Walsh, & Vannatta, 2001).

Inclusion of classroom technology use training in methods classes has resulted in increases in pre-service teacher confidence and proficiency levels regarding integrating technology into classroom instructions and lessons and the learning environment (Halpin, 1999). Subsequent recommendations suggested the value of integrating technology training earlier within teacher education coursework (Beyerbach, Walsh, & Vannatta, 2001; Krueger, Hansen, & Smaldino, 2000; Ropp, 1999, Stuhlmann & Taylor, 1999).

The constructivist model aligns with the fundamental belief that the knowledge base is constantly fluctuating and becomes stronger through discovery methods of testing and reevaluating. Since computing technology continually changes, teachers need to develop and maintain technology skills in order to maintain relevant technology integration within their classrooms. It is recommended that education programs need to build self-efficacy and self-confidence with computing technology integration and constructivist teaching (Blocher, deMontes, Tucker, & Willis, 2000). However, without courses that immerse undergraduate students in a constructivist approach in the many uses and applications of computing technology in the classroom, many of them will continue to view computing technology as an add-on teaching tool rather than as a device that naturally complements a constructivist approach within all academic subject areas. This research sought to identify specific skills and define constructivist methods for inclusion of technology into the pre-methods education curriculum that will prepare pre-service teachers to effectively infuse computing technology into their lesson plans.

Relevance and significance

Teacher education programs are expected to facilitate the development of teachers who are computer literate and able to integrate technology into the classroom (Beyerbach, Walsh, & Vannatta, 2001). Therefore, learning to incorporate technology into classroom learning is becoming a focal point in teacher education programs. Many teacher preparation programs require pre-service teachers to complete an introductory computer science course in an attempt to produce computer literate teachers who will hopefully use technology effectively within their classrooms (Abbott & Faris, 2000). But a focus on computer applications alone fails to prepare pre-service teachers to use technology as an effective teaching tool (Gibson, 2002).

Schrum (1999) summarizes this by stating, “It is important to look carefully at how teachers learn about technology, for they are quite clearly the key to transforming teaching and learning” (p. 83). Reports indicating that less than one-fifth of our nation’s educators feel prepared to integrate technology into the classroom send a clear signal that a vital element is missing in teacher preparation programs. Efforts to include better preparations have begun for pre-service teachers within methods coursework and during student teaching, but the foundation needs to be laid earlier in the education program.

Laffey and Musser (1998) suggested that teacher education programs need to incorporate technology into the curriculum in order to motivate teacher candidates to creatively utilize technology. Pre-service teachers who experience modeling of relevant usage of technology will be more likely to implement this approach within their own classrooms. Recommendations from studies that infuse technology into education methods courses concur that technology training should begin early in the education program – into education courses taken prior to methods coursework – and continue throughout. Studies of this earlier infusion are needed in order to determine if technology integrated into pre-methods education courses have a positive impact on the attitudes and confidence levels of pre-service teachers.

Globally, technology is developing exponentially and access to information is virtually available almost anywhere at anytime. Technology has been and continues to transform education just as it does businesses and within our personal lives. If current educational systems adapt appropriate technological functions too slowly, then they will be preparing students for a world that no longer exists. Educators need to model how best to incorporate technological changes and become process instructors and purveyors of guided learning – to use technology to “teach students how to research, what to do with the information gathered, and how to use it to solve problems” (McCain & Jukes, 2001, p. 114).

Hypotheses investigated

This study measured and compared the self-efficacy and confidence levels of pre-service teachers who had participated in an introductory computer course to those who had participated in pre-methods education courses with constructivist-based technology integration approaches. It also measured and compared the self-efficacy and confidence levels of pre-service teachers who had participated in an introductory computer course and a pre-methods education course with constructivist-based technology integration approaches to those who experienced only the introductory computer course or one of the education courses with the constructivist-based technology integration approaches. Baseline data from the findings were utilized to examine the educational technology aspects of the teacher education program.

The purpose of this study was to compare the impact of embedding technology training into three pre-methods teacher education courses against the traditional approach of requiring education majors to enroll in only one introductory computer course. These education courses were prerequisites for enrollment into a methods course. The hypotheses to be investigated were:

- Hypothesis One: Prior to methods enrollment, education majors who experience performance-based technology integration within core education coursework will have significantly different self-efficacy levels regarding technology integration than those who rely solely on the introductory computer course for their technological base.
- Hypothesis Two: Prior to methods enrollment, education majors who experience performance-based technology integration within core education coursework will have significantly different confidence levels regarding technology integration than those who rely solely on the introductory computer course for their technological base.

Previous studies addressed the impact of incorporating technology into education methods coursework and student teaching experiences for specific education majors yet these did not investigate: the impact of incorporating technology into pre-methods education coursework among a heterogeneous representation of education majors, a comparison of perceived skill attained by the pre-service teachers after taking the introductory computer course and/or the pre-methods courses with technology embedded within the coursework. Jao (2001) states that the attitude of the teacher can have an impact on the view of the students and Rogers (as cited in Kjetsaa, 2002) emphasizes the idea that teacher modeling of technology uses aids in the diffusion of knowledge in the classroom. Thus, the pre-service teacher needs to develop skills in technology and modeling of technology integration. This study provides insight into the impact of integrating technology into pre-methods education coursework – utilizing the ISTE 2000 standards – on the perceived skill sets of pre-service teachers. This insight can be used to develop teacher education

curriculum as a means of producing teachers with the skills necessary to integrate technology into the K-12 classroom.

Limitations

Many colleges and universities are embedding technology integration into education methods courses and student teaching experiences. This study focused solely on integrating technology into three pre-methods courses required by every education major attending the State University of New York – College at Oneonta during the Fall 2003 semester: Issues in Education (EDUC 106), Diversity and Teaching (EDUC 201), and Philosophy and Foundations of Education (EDUC 206). Data was collected to compare self-efficacy and confidence levels of students receiving the constructivist-based technology integration treatment in selected sections of EDUC 106, EDUC 201, and EDUC 206 with those of education majors enrolled in Introduction to Computers (CSCI 100) during the Fall 2003 semester. Because students usually pre-register for these classes, the sample groups tended to be more in line with convenience sampling (Gay & Airasian, 2000).

The comparison of two different curricular approaches is typical of experimental research. This study involved comparing specific college courses (EDUC 106, 201, and 206) that integrate technology skill practice and links to pedagogy to the more traditional introductory computer course that focused on six technology skills: spreadsheet, database, web pages, computer communications, word processing, and multimedia. All participants completed the same pre-survey to establish baseline data that was compared to data collected from the post-surveys that all participants completed.

Participants who were Education majors and enrolled in CSCI 100 for Fall 2003 completed pre-surveys within the first few weeks of the semester. The data provided by Education majors enrolled in CSCI 100, but not in the six selected sections of the three education courses receiving the constructivist-based technology integration treatment, were utilized for analysis to answer Hypotheses 1 and 2. The surveys had items for each of the six skill areas as well as the perceived confidence and self-efficacy regarding technology integration. These students experienced the traditional skills approach and then completed post-surveys at the end of the semester. The statistical analysis indicated any change (increase, decrease, or no significant difference) from pre- to post-survey.

Students enrolled in the test sections of EDUC 106, 201, and 206 selected for the study also completed the same pre- and post-surveys as the CSCI 100 students. The students in each of the EDUC courses had five of the six (spreadsheet, database, web pages, computer communications, multimedia, and word processing) skill areas incorporated into their education coursework. The constructivist approach involved the participants utilizing the technology skills as a means of completing tasks that have classroom applications. They reflected upon the applications to the classroom as a means of constructing their understanding of technology skills and integration. Prior to treatment beginning these students also completed the pre-surveys. These students experienced a constructivist approach and then completed post-surveys at the end of the semester. The statistical analysis indicated any change (increase, decrease, or no significant difference). The data addressed in each of EDUC courses were compared with the CSCI 100 data for the same five areas. This indicated if there was a significant difference as specified in the hypotheses.

Summary

The quantitative and qualitative data collectively reflected positive self-efficacy and confidence levels for all the approaches tested. Participants experiencing the embedded constructivist approach, the standard introductory computer course, or those with both indicated that technology integration is possible within their future classrooms once these pre-service teachers become teachers.

The literature review indicated that technology integration should begin earlier within the college education program. It was suggested technology integration should appear prior to methods coursework. The results of this study appear to align with this premise since the most significant changes occurred within the initial college education course (EDUC 106). If the initial education course embeds technology that affords pre-service teachers successful opportunities to develop perceived self-efficacy and confidence levels of at least four on a five-point Likert scale then successive courses can focus on developing the applications of technology in the classroom so that pre-service teachers entering their methods coursework

are able to elaborate on integration possibilities beyond their knowledge of and experience with the basic levels exhibited in the interviews.

Two of the three tasks utilized in the initial education course have since been added as tasks for all sections of that course. Qualitative data appears to confirm the belief that pre-service teachers entering methods are able to develop integration activities into early lesson development. This needs to be validated via quantitative data collection.

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Increasing the Impact of Vicarious Learning Experiences through the Use of Groups Discussions and Question Prompts

Yekyung Lee
Peggy A. Ertmer
(In full collaboration)
Purdue University

Abstract

This study examined, in a vicarious learning environment, the effects of group discussions and question prompts on pre-service teachers' knowledge/skills and self-efficacy judgments for technology integration. Sixty-five students enrolled in an introductory educational technology course at a large Midwestern university participated in the study. Vicarious experiences for technology integration were delivered through *VisionQuest*, a Web site that provided examples of successful technology integration. A 2×2 factorial research design was implemented with the use of group discussions and question prompts as independent variables. Dependent variables were students' perceptions of knowledge, skills, and self-efficacy for technology integration measured through pre and post surveys. While three of the four conditions showed significant increases in perceptions of knowledge and skills, ANOVA results showed no significant differences among treatments. Results suggest that vicarious experiences alone can be effective, and that the addition of more conditions may have distracted students from the content/message of the teacher models highlighted in *VisionQuest*.

Introduction

Vicarious learning occurs when learners observe the actions of others and decide which actions will be effective or non-effective for their own enactment of a task (McCown, Driscoll, & Roop, 1996). From a social cognitive perspective (Bandura, 1997; Schunk, 2000), vicarious experiences can accelerate learning over what would be possible if we had to perform every behavior ourselves in order to learn. This is especially true when trying to learn complex skills such as riding a bike, swinging a golf club, or using computers in the classroom. By observing experts, teachers, and other models, learners may get a head start toward their own mastery of difficult tasks.

Vicarious experiences have been used to increase students' self-efficacy, or confidence, for performing tasks similar to those performed by the observed models (Bandura, 1986; Ertmer, Conklin, Lewandowski, Osika, Selo, & Wignall, 2003; Gist, Schwoerer, & Rosen, 1989). According to Bandura (1997), self-efficacy comprises personal beliefs about one's capability to perform at specified levels and, as such, is considered to be the "key factor of human agency" (p. 3). While not as strong of a source of efficacy information as personal mastery experiences, vicarious experiences often offer a more feasible method for enhancing pre-service teachers' self-efficacy for technology integration, especially given the lack of resources and logistical difficulties involved in providing students with relevant mastery learning opportunities (Albion & Gibson, 2000; Ertmer et al., 2003). (Note: Additional sources of efficacy information [e.g., social persuasion and physiological states] are less powerful and were not considered relevant to this study.)

Technology also offers an effective means for delivering vicarious experiences. In a study that explored the effectiveness of electronic models for increasing preservice teachers' self-efficacy for technology integration (Ertmer et al., 2003), results showed a significant increase in students' judgments of confidence after viewing successful models in a hypermedia environment. Albion and Gibson (2000) obtained similar results: After observing realistic examples of technology integration in an interactive multimedia environment, preservice teachers showed a significant increase in their self-efficacy for technology integration. Along similar lines, Driscoll and her colleagues (2003) demonstrated the benefits of observing dialogue-like discourse (as opposed to monologue-like discourse) that was modeled by a virtual tutor in a computer-supported environment. That is, overhearing dialogues containing deep questions helped learners recall information and thus, increased their learning outcomes. Taken together, these studies suggest the possibility of increasing learning and self-efficacy through the use of vicarious experiences delivered via computer-based environments.

Despite the many benefits noted in the literature, vicarious learning is not without its challenges. Since vicarious learning is, in and of itself, a fairly passive learning activity, learners may disengage from the activity entirely or fail to attend to critical aspects of the performance, thus missing out on the important benefits to be gained. Given these potential difficulties, it may be beneficial to combine vicarious experiences with additional strategies that will enable students to become, and stay, mentally involved in the experience. For example, Wang, Ertmer, and Newby (2004) demonstrated that vicarious experiences and goal setting, combined, were more effective than either strategy alone for increasing preservice teachers' self-efficacy for technology integration. According to Schunk (2000), discussion groups and questioning are both effective methods for promoting active learning, and thus may increase students' engagement in the vicarious learning experiences.

Potential Benefits of Group Discussion

According to Koschmann, Kelson, Feltovich, and Barrows (1996), meaningful group discussions can lead to cognitive benefits by engaging students in deep reflections on their ideas. By exchanging ideas and considering others' perspectives, learners are prompted to reflect on their existing ideas as well as to integrate new ideas into their existing knowledge. Also, the cognitive processes involved in asking questions, providing explanations in response to questions, and elaborating on one's ideas to provide these explanations, all contribute to learning (Cohen, 1994; Slavin, 1996). Cochran-Smith and Lytle (1999) described how teachers' engagement in collaborative dialogue within a community of inquiry enabled them to share knowledge and co-create new understandings. Albion and Gibson (2000) emphasized the importance of including collaboration in multimedia-based, problem-solving environments, stating that the efficacy of problem-based learning stems from discussions among group members.

Results from Levin's (1995) study on the contributions of case discussions to teachers' thinking, indicated that discussions helped student teachers and less experienced teachers clarify and elaborate on their ideas about issues in a case. Gokhale (1995) explored the effects of collaborative learning on drill-and-practice and critical thinking tests, and concluded that collaborative learning had a significant positive effect on critical thinking by helping students learn from each other's experiences and knowledge, and by stimulating more in-depth reflection.

Research also supports the hypothesis that group discussions can contribute to increased self-efficacy. In Rushton's in-depth qualitative study (2003), findings showed that preservice teachers' interactions with students and mentoring teachers helped them "cope with their doubts and abilities" (p.167), which led to increases in self-efficacy. Wilson (1996) examined the effectiveness of field experiences in a teacher certification program for elementary science, math, and technology students and noted that participants preferred small group discussions, which also increased their self-efficacy. Furthermore, learners have been shown to gain confidence and improve their performances when they observe models who initially showed the same fears as themselves, but who gradually reached mastery levels of performance (Driscoll, 2000). It was hypothesized that student interactions within discussion groups, as used in the current study, would help learners develop self-efficacy in similar ways. That is, learners' self-efficacy was expected to increase if they observed multiple people, similar to themselves, discussing and solving problems related to technology integration (Brown & Inouye, 1978; Schunk, 1987).

Still, not all studies indicate that group learning is more effective than individual learning. A study by Snyder and Sullivan (1995) reported that when given the learning goal of changing misconceptions, students working individually scored significantly higher on posttest scores than those who worked in groups. Research specifically aimed at identifying the relationship between group discussions and learning in computer-based environments also demonstrated no significant differences in achievement between students working in groups and students working individually (Carrier & Sales, 1987; Werner & Klein, 1999). Contradictory findings on the effectiveness of group work in computer-based and face-to face environments, to date, suggest the need to explore how peer interactions affect both learning and self-efficacy outcomes when used in combination with vicarious experiences.

Potential Benefits of Question Prompts

Questioning is another strategy that might increase self-efficacy and learning, especially when used in combination with group discussions. For example, evidence for the relationship between questioning and self-efficacy can be found in a study by Powell and Ramnauth (1992), which suggested that teachers' confidence increased when teachers made comments or suggestions and asked questions to stimulate the thought processes of each other. Additional studies suggest that by asking questions, peer interaction can be structured in ways to promote both cognitive development and self-efficacy. For instance, a study by Ge and Land (2003), which investigated the effectiveness of question prompts and peer interactions when used during tasks involving ill-

structured problems, revealed that question prompts facilitated students' performance. In their study, qualitative data indicated that students' thinking was enhanced during peer interactions in terms of problem representation, explanation, justification, monitoring, and evaluation. Van Zee and Minstrell (1997) suggested that when teachers ask reflective questions (i.e., questions that elicit further thinking about a topic), they encourage their students to clarify their meanings, consider various perspectives, and monitor their own discussions and thinking.

Certain types of prompts have been shown to be effective in computer-based environments as well. Davis and Linn (2000) demonstrated that for knowledge integration to occur, self-monitoring prompts, which helped learners reflect on the planning and progress of activities, were more effective than activity prompts that simply directed learners' attention to completing the activities. A study by Han, Crooks, and Xie (2005) showed that using unstructured question prompts (prompts which appeared separately from, but not inserted within, the text passage on the computer screen) can be effective for performance transfer especially when learners have to key in answers to the computer program.

It should be noted, however, that research findings on the effectiveness of questioning have been inconsistent. Wang (2001) explored the effects of summarization and structured questions, hypothesizing that structured questions would activate metacognitive and critical thinking skills. However, results of this study indicated no statistical effects of either treatment on transfer tasks.

While there are inconsistent reports on the effectiveness of group work and question prompts in both face-to-face and computer-based environments, in general, the literature suggests that both methods may have a positive effect on learning by facilitating reflection and critical thinking. This suggests that group discussions and question prompts may enhance the use of vicarious experiences with preservice teachers and thus may have an impact on the growth of their knowledge, skills, and self-efficacy.

The current study was designed to examine, in a vicarious learning context, the impact of group discussions and question prompts on students' knowledge/skills and self-efficacy judgments for technology integration. Specifically, this study was guided by the overarching research question: What are the effects of group discussions and question prompts on preservice teachers' judgments of computer competency and computer self-efficacy in a vicarious learning environment?

Based on the literature above, it was hypothesized that students who participated in group discussions while observing exemplary technology-using teachers (i.e., participated in vicarious experiences) would have increased perceptions of competency and self-efficacy in this area. It was also hypothesized that students who received question prompts to guide their reflections during vicarious learning experiences would demonstrate a significant increase in judgments of competency and self-efficacy for technology integration. Finally, it was hypothesized that students who participated in group discussions and received question prompts would have the greatest increase in judgments of competency and self-efficacy compared to students who received either one of these conditions alone.

Methods

Research Design

A 2 × 2 (group discussion × question prompts) research design was used to examine the impact of group discussions and question prompts on preservice teachers' judgments of competency and self-efficacy for technology integration. The independent variables were combined to form four experimental conditions: (1) NGD/NQP (the control group, that is, no group discussion and no question prompts), (2) NGD/QP (no group discussion, but with question prompts), (3) GD/NQP (group discussions, but no question prompts), and (4) GD/QP (group discussions and question prompts). The dependent variables comprised participants' pre- and post-perceptions of their competencies (knowledge and skills) and self-efficacy for technology integration.

Participants and Sampling Method

Participants were solicited from 420 students enrolled in an introductory educational technology course during the spring of 2005 at a large Mid-western University. The 2-credit course consisted of weekly 1-hour lectures and 2-hour lab sessions, and was designed to provide students with the foundational knowledge and skills necessary to integrate technology into K-12 classrooms. Participation was solicited during the 8th week of the semester during 18 lab sessions that were taught by instructors unrelated to this study. An approved human subjects protocol was used and 65 students participated in the study.

Participants included 43 females and 22 males, ranging in age from 18 to 41 years (M = 19). The majority were freshmen (n=36) and sophomores (n=21). Participants were majoring, primarily, in either secondary (n=36) or elementary (n=18) education. At the time of the study, 92% of the students indicated that using computers was somewhat or very easy. In addition, 86% of the participants noted that it was important, or very important, to use computers in the K-12 classroom. Results of initial ANOVAs indicated no significant differences among the treatment groups in terms of age, class, major, or pretest scores on either the competencies or self-efficacy subscales.

Instrument

The *Technology Integration Knowledge, Skill, and Self-efficacy Assessment* (TIKSSA) survey, used to measure the dependent variables, was developed after reviewing similar surveys in the literature (Schunk & Ertmer, 1999; Wang, Ertmer, & Newby, 2004). TIKSSA was examined for both content and construct validity. A review by a content expert in the area of self-efficacy provided evidence of content validity. Evidence of construct validity was gathered by conducting an exploratory factor analysis (EFA). EFA was chosen based on the fact that TIKSSA was a new scale, and it was necessary to identify factor patterns for each subscale. For EFA, principal factors analysis methods and the scree test were used to extract factors and determine the number of factors. Results indicated that for both subscales items loaded heavily on one factor, respectively: Skills/knowledge scale with an eigenvalue=8.52, explaining .78 of the total variances, and the self-efficacy scale with eigenvalue=9.69, explaining .85 of total variance. While readers should not consider the results from this EFA to be entirely reliable, due to the small sample size, it does provide preliminary evidence of construct validity.

To complete the TIKSSA, participants rated their levels of agreement (from 1-not well to 4-very well) on 32 Likert-style items reflecting their current perceptions of competencies (knowledge and skills) and self-efficacy for tasks such as designing and managing technology integrated classrooms and overcoming barriers. Sixteen items were used to measure students' perceptions of knowledge and skills (e.g., "I know how to discuss my vision of technology integration with school colleagues or supervisors."); an additional 16 items were used to measure self-efficacy (e.g., "I feel confident that I can implement my vision of technology integration within my future classroom."). Surveys were accessed and completed online: the pre-survey was completed approximately a week before the study; the post-survey was completed immediately after participation in the treatment. Cronbach alpha coefficients indicated that the two subscales were highly reliable (knowledge/skills = .95; self-efficacy = .96)

Instructional Materials

Students in all four treatments reviewed *VisionQuest* (Ertmer et al., 2003) before participating in the treatment conditions. *VisionQuest* is an instructional website that allows users to explore how classroom teachers effectively integrate technology into their classrooms despite differences in subjects, resources, and student characteristics.

The VQ website consists of three main sections (planning, implementation, and assessment) related to teachers' efforts toward achieving technology integration. Teacher cases are presented through various media including video, text, and graphics; relevant artifacts (lesson plans, assessment tools, student work, etc.) are also included.

Procedures

The entire experiment was conducted over four days during the ninth week of the semester. The researchers assigned treatment conditions based on the number of students who had signed up for each time slot and the overall numbers for each experimental group. Students learned which treatment they would receive after they arrived at the labs. Due to scheduling conflicts, a small number of participants (n=7) completed the study two weeks later.

As participants arrived at the lab, they received two handouts: 1) *VisionQuest* User's Guide, and 2) General or Question Prompts Worksheet. The first handout familiarized students with the website and outlined the procedures for the study. The second handout guided students' individual reflections or group discussions over the contents of *VisionQuest*. Depending on their treatment conditions, students received either a Question Prompt Worksheet (handout containing question prompts and space to record notes) or a General Worksheet (checklist of items to view, with space to take notes). Table 1 summarizes the types of worksheets and activities given to each experimental group. More specific descriptions of the worksheets are provided below.

Table 1. Treatment Conditions in 2 x2 Factorial Design

Question Prompt / Discussion Group	No Question Prompt (NQP)	Question Prompt (QP)
No Discussion Group (NDG)	General worksheet Individual work	Question prompt worksheet Individual work
Discussion Group (DG)	General worksheet Group discussion	Question prompt worksheet Group discussion

Question Prompts Worksheets (QP)

Participants in the NGD/QP and GD/QP groups received a set of 11 questions to guide them as they explored the *VisionQuest* website. Specific prompts included, for example: "Which class activity, from among all three cases, did you think was most innovative and effective? Why?" and "How were teachers' visions reflected in their students' learning?" The questions were designed to stimulate students' critical thinking on issues related to technology integration. Researchers emphasized the purpose of these questions on the worksheet and also orally at the start of the lab sessions.

General Worksheet (NQP – No question prompts)

Participants in the groups without question prompts were given checklists designed to ensure that they explored important components of *VisionQuest*. The difference between this worksheet and the question prompts worksheets was that it asked the students to take notes on general ideas related to each of the components of *VisionQuest* rather than responding to specific questions or prompts.

Discussion Groups (DG)

Students in the DG/NQP and DG/QP groups participated in discussions after exploring components of *VisionQuest* independently. Most groups had three participants. For each time slot designated for group discussions, if the number of students was not adequate to make groups of three, groups of four were organized by the researcher. Participants were randomly assigned to groups as they arrived at the lab. Either the general worksheet or the question prompts worksheet was provided to each group. Each group was required to submit one worksheet to the researcher. The total time spent reviewing and discussing *VisionQuest* was also recorded. Discussions lasted from 60-90 minutes, depending on the interaction level of the participants. Participants who were not assigned to the group discussion treatments (NGD/QP and NGD/NQP) reviewed and filled out their worksheets individually.

Results

This study was designed to determine the effect of question prompts and group discussion on students' judgments of technology integration competencies and self-efficacy while engaged in vicarious learning experiences. A two-way ANOVA indicated no significant effects of either independent variable (question prompts, discussion groups) on the dependent variables ($F = 1.04$, $p = .38$ for competency judgments; $F=.57$, $p=.64$ for self-efficacy). In addition, there were no statistically significant interactions between the independent variables on competencies ($F=.11$, $p = .74$) or self-efficacy ($F = .00$, $p = .96$). The calculated effect size (omega square) was .03, suggesting that the systematic variance was only minimally explained by the treatment condition in which the students participated.

Results of paired t-tests indicated that students in all treatment groups, with the exception of the NDG/QP group, showed significant increases in their perceptions of knowledge and skills from pre- to post-survey. Results from paired t-tests also showed significant increases in judgments of self-efficacy from pre to postsurvey for students in the Control Group ($p = .001$), and the DG/NQP ($p = .001$). Students in both treatment groups that used question prompts (NDG/QP and GD/QP) did not show significant increases in self-efficacy. In addition, the students who used question prompts individually (NDG/QP) did not show significant increases in perceptions of knowledge and skills. Surprisingly, this group also had the lowest scores on the postsurvey. Means for both subscales on the pre- and post-surveys, as well as t and p values, are included in Table 2.

Table 2. Treatment Group Scores on the TIKKSA Pre- and Post-Survey

Group	n	Knowledge/Skills				Self Efficacy			
		Pre-Mean	Post-Mean	t	p	Pre-Mean	Post-Mean	t	p
NDG/NQP (Initial Control Gp: Open-ended Wksht)	14	2.56	3.06	4.37	.0008	2.77	3.10	4.10	.0013
NDG/QP	16	2.49	2.76	1.80	.092	2.66	2.88	1.81	.090
DG/NQP	18	2.49	3.10	4.29	.0006	2.58	3.16	3.99	.001
DG/QP	17	2.47	2.93	3.88	.0015	2.75	2.99	1.11	.2845
NDG/NWK* (Control: No Wksht)	15	2.45	2.90	4.48	.0006	2.60	2.97	3.01	.010

(**Note*. This condition was added to address initial findings suggesting that the original control group may have benefited from the use of an open-ended worksheet.)

Because this result was unexpected, we analyzed the responses that students wrote on their group and individual worksheets to obtain further insight into how the prompts may have guided their interactions with *VisionQuest*. In general, responses of students in the question prompt groups were composed of sentences that tended to repeat pieces of information found on the VQ website, contrary to the expectation that they would be more substantive and reflective (e.g., "The teacher … used technology by having her students create their own songs" (DG/QP); "… school teachers integrated their classroom to a more hands-on experience. … The class layout contained 16 computers."). In contrast, responses of students in the non-question prompt groups appeared to be in the students' own words, and tended to refer to broader ideas rather than specific facts (e.g., "Incentives are based on the teacher's beliefs, and student's motivation," and "computers can help students judge information and make decisions with their own conclusions.").

Again, this illustrates an unexpected trend. That is, students who used a worksheet that simply asked them to "jot down their ideas" related to components of *VisionQuest*, seemed to respond in more reflective and thoughtful ways than those who used a worksheet that asked them to respond to specific questions (e.g., "Describe how teachers' visions influenced the design of their classroom activities or materials. Give at least one specific example."). An unintended effect may have occurred in which students' attention was directed toward answering questions, as opposed to reflecting on what they were observing in *VisionQuest*. Thus, the more general worksheet may have actually served as the type of reflective prompt we were hoping to create with the more directed questions. In effect, this may have modified the condition that we intended to serve as a control into one that utilized a different, and perhaps more effective, type of question prompt.

Due to these findings, an additional condition was added to the design of the study and implemented with a new group of 13 students enrolled in the same course the following semester. ANOVA results indicated no significant differences between the new and initial participants in terms of class, age, or computer skills. In the hopes of creating a "true" control condition, that is, one in which no prompts were provided, students in the new condition did not use any worksheets while exploring *VisionQuest*. Rather, students were simply asked to mark, on a provided checklist, those parts of *VisionQuest* they had viewed. Thus, the students in this condition did not write down any notes or comments as they went through the program. While results of a t-test showed a significant increase from pre to postsurvey on both the knowledge/skills subscale ($p=.006$) and the self-efficacy subscale ($p = .01$), one way-ANOVA results indicated no significant differences between this control group and the other NDG treatment conditions on either the knowledge ($F=1.21$, $p = .31$) or self-efficacy ($F = .66$, $p = .52$) subscales. Students in the initial Control Group showed the greatest increases on both the knowledge scale ($t = 4.37$; $p = .001$) and the self-efficacy scale ($t = 4.10$; $p = .001$).

Discussion

This study was designed to determine if the effects of vicarious experiences could be increased when used in conjunction with additional instructional strategies, known to be effective in promoting learning. For example, in a previous study, Wang et al. (2004) found that the use of goal setting strategies, when paired with vicarious experiences, significantly increased students' judgments of self-efficacy for technology integration. In this study, we examined the specific benefits of pairing vicarious experiences with group discussion and question prompts. Despite the fact that students in all but one treatment group significantly increased their perceptions of knowledge and skills,

the additional use of discussions and question prompts did not create any significant differences among students' perceptions across groups. In fact, students who viewed *VisionQuest* individually, using only an open-ended worksheet, appeared to make the most gains in perceptions of knowledge, skills, and self-efficacy. Adding group discussions and/or question prompts did not appear to enhance the benefits of these vicarious learning experiences over those which occurred without them.

In this study, students who participated in group discussions while using *VisionQuest* did not benefit significantly more or less from the vicarious learning experiences than those who did not participate in group discussions. While previous research (Gokhale, 1995; Levin, 1995) has suggested that group discussions can stimulate students' reflection and understanding of complex issues, and may raise judgments of self-efficacy (Wilson, 1996), this was not the case in our study. This may have been due to a number of reasons including having a relatively small number of participants in each treatment group, as well as a relatively limited amount of time to carry out a number of in-depth discussions on a variety of topics. In addition, students may not have been comfortable discussing their ideas with others whom they did not know very well, or simply may not have been motivated to do any more than was required to complete the assigned tasks. Because these activities were not part of their required curriculum, students may have judged that they were not particularly interesting or relevant to them. This may have caused them to simply "go through the motions" of discussing the content, but with no real incentive to reflect deeply on the questions at hand. Furthermore, adding supplementary materials or tools for group work may actually have had a negative effect on learning. A study by Van Boxtel, Van der Linden, and Kanselaar (2000) demonstrated that additional materials, such as the use of textbooks, can inhibit elaborative and constructive interaction among peers. Other researchers (Webb, 1989; Werner & Klein, 1999) have reported similar findings: group learning does not always lead to significantly greater learning outcomes compared to individual learning.

Particularly interesting in this study were the results related to the use of question prompts. While it was expected, based on the literature, that question prompts would support students' learning by stimulating deeper thinking about the content (Ge & Land, 2003; Van Zee & Mistrell, 1997), students in this study who did not use question prompts scored consistently higher on the post-survey scales than those who did. Although these differences between groups were not statistically significant, as demonstrated by the ANOVA results, they do suggest an interesting trend.

By asking students to respond to questions that guided their learning in a specific direction, researchers may have inadvertently focused students' attention on specific answers, rather than on the rich vicarious experiences being presented on *VisionQuest*. These prompts, or questions, then, may have actually distracted students from fully attending to the vicarious experiences they were expected to observe, thus leading to smaller gains in perceived knowledge, skills, and self-efficacy. While this result was not expected, there is some evidence in the literature to support this finding. For example, Davis (2003) found that students actually incorporated more ideas, evidence, and scientific principles in their reflections when guided with "generic" prompts (e.g., "Right now, we're thinking…") rather than more "directed" prompts (e.g., "To do a good job on this project, we need to…"). She speculated that students who received the directed prompts may not have been able to thoroughly interpret what was needed or they may have been superficially completing the task. This seems to have been true in our study as well. Participants who did not use question prompts may have had more opportunity to engage in broader reflections over the content, guided by their own judgment, and thus engaged in deeper reflections compared to those using more specific question prompts.

While it is possible that the students in this study were not motivated or prepared to think deeply about the content presented (Wang, 2001), another possibility is that the relatively long list of question prompts (n= 11) may have caused fatigue in participants. According to Kobayashi (2005), cognitive fatigue can have a negative influence on note-taking during long presentations. A full review of *VisionQuest*, without the additional requirement of recording ideas gained from the site, would take 90 minutes or more to complete. Adding a relatively lengthy worksheet to the review requirements may have caused a loss in concentration and motivation. In contrast, the no-question prompt groups were asked to record ideas related to only 5 key items, a substantially smaller number.

The results of this study suggest that vicarious experiences alone may increase learning and self-efficacy without the help of other methods. The addition of more conditions may have distracted students from the content/message of the teacher models highlighted on *VisionQuest*. It is possible that the cognitive load imposed on students during vicarious learning activities does not allow enough room for processing other, seemingly competing, instructional tasks. Conversely, it is possible that the extra tasks required too much additional attention and thus were not helpful in guiding students' efforts on the initial task (Chandler & Sweller, 1991; Sweller & Chandler, 1994). In addition, cautious administration of additional strategies should be considered when providing vicarious learning experiences. For group discussions to facilitate reflection, methods for developing group dynamics and increasing students' motivation to actively participate could be necessary. Question prompts that direct reflection

could be more effective when they are not focused narrowly in specific directions and allow freedom for learners to choose their own approaches to processing the information gained from vicarious experiences.

Limitations

The results of this study are limited by the 1) small number of participants, 2) lack of time for group dynamics to develop, 3) voluntary nature of participation in study, which was to "earn" credit (students were just "completing a task" and may not have understood the relevancy of *VisionQuest* to their future career as teachers), and 4) structured questions that unintentionally narrowed the reflective process of learners. Assuming that group discussions and question prompts have the potential to increase learning outcomes, future research should incorporate strategies that address these limitations. For example, using *VisionQuest* as a required activity in a course might eliminate a few of the concerns noted above. That is, asking students to discuss *VisionQuest*, with others whom they know, to address a specific course goal, might have allowed the benefits of both group discussions and question prompts to emerge. These are fruitful areas for future work.

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Investigating Ethical Issues Experienced by Professional Technologists in Online Course Design and Web-based Training Situations

Hong Lin, Ph.D.
Oklahoma State University

Abstract To correspond to the AECT Code of Professional Ethics and the professional journal *TechTrends*' ethics columns, this paper provides empirical data regarding ethical issues associated with the use of instructional technology in design and training situations. In-depth interviews of 20 practitioners were conducted. The top three concerns reported were related to copyright, learner privacy, and accessibility issues. Diversity, conflicts of interest, and professionalism concerns also were raised. Recommendations to researchers, managers, and practitioners were discussed.

Keywords: Ethics, instructional technology, training

Course design and training is undergoing great changes due to the advancement of technology and such new styles of learning as online learning. For this reason, educational institutions have motivated to increasingly incorporate instructional technology into course design and training. Such a change, in turn, has enabled learning and training to become increasingly digital, mobile, and virtual. Meanwhile, the instructional technology that has profoundly impacted course design and training practices has also given rise to the proliferation of ethical issues relating to the applications of the technology. Such ethical issues include, but are not limited to, digital copyright infringement (Mabry & O'Driscoll, 2003), the violation of private online information (Mason, 1995), and other inappropriate use of instructional technology.

To address the emerging ethical issues in the field of educational communications and technology, the Association for Educational Communication Technology (AECT) has established a Code of Professional Ethics for its members with complex and comprehensive guiding principles that aim at a wide range of professional behaviors. Correspondingly, the AECT professional journal *TechTrends* has published a series of ethics columns to interpret the Code established by AECT. The AECT Code of Professional Ethics and the *TechTrends* series have undoubtedly heightened the field's awareness of the importance of ethical behaviors.

However, according to Mabry and O'Driscoll (2003), these largely speculative discussions of ethical challenges and ways to navigate the challenges in these related fields are not "grounded in empirical research," and "by far the least researched perspective is an empirical one that examines ethics and ethical dilemmas actually encountered in practice" (p. 82). Yeaman (2004) echoed this view by claiming that professional ethics and the misuse of technology by professional technologists "may be a rather neglected topic for research" (p. 16).

The lack of literature in the area of ethics and instructional technology is incongruent with the fact that more and more practitioners are employing instructional technology on a daily basis in design and training situations. Actually, practitioners and researchers in the field have had a long history of examining ethical obligations and developing expectations for professional behavior as well as a code of ethics. The purpose of this study, therefore, was to identify ethical issues and coping strategies experienced by professional technologists in design and training situations. It was hoped that the results would contribute to the current literature about ethical obligations in the field of educational communications and technology.

Problem Statement

Little is known about the ethical challenges faced by professional technologists in online course design and Web-based training situations. Instead, studies associated with the use of instructional technology primarily focus on the implementation of technology (Bowen, 1998); the effects of technology on process variables, such as learner control, feedback, and usability (Torraco, 1999); principles of effective online courses (Speck, Knowlton, & Weiss, 2000), and competences for online teaching (Goodyear, Salmon, Spector, Steeples, & Tichner, 2001). Moreover, studies related to application of technology are often reported in the Information Technology (IT) field rather than in the educational communications and technology arena.

Literature Review

A review of the literature focused on ethical issues in the applications of instructional technology will provide a framework that will help us compare what we already know to areas identified in this study that need further exploration.

Copyright

In the literature, discussions of digital copyright mainly focus on its legal perspectives. Two legislations are relevant to the use of digital copyright in educational institutions. The Digital Millennium Copyright Act of 1998 limits the liability of nonprofit institutions of higher education—when they serve as online service providers and under certain circumstances—for copyright infringement by faculty members or graduate students (UCLA Online Institute, 2004). The TEACH Act, an acronym for the Technology, Education, and Copyright Harmonization Act, gives more freedom to accredited, nonprofit educational institutions to use copyright protected materials in distance education—including on Web sites and by other digital means (the American Library Association web site).

On the other hand, the literature also covers discussions of copyright from its ethical perspectives. Mabry and O'Driscoll (2003) pointed out that to lower the cost of designing, developing, and delivering learning content, some organizations reuse and reorganize learning content that is already available. In this sense, professional technologists are susceptible to such ethical breaches as taking others' credit consciously or inadequately and even becoming involved in high-tech intellectual property crime (Mabry & O'Driscoll, 2003). Similarly, Kebbati (2001) identified some unethical computer behaviors in a high school classroom such as the confusion of fair use guidelines and copyright clearance for teaching. In university settings, Lan and Dagley (1999) cautioned that as university professors busily create online courses and distribute instructional materials online, educational technologists, legal counsel, and university administrators need to advise faculty of the dangers of trying to do things the old way in a new format, that is, putting hardcopy materials online without copyright clearance.

Confidentiality

With its swift expansion and growing popularity, information technology provides broad access to confidential resources (Pourciau, 1999). Violation of individual privacy and the abuse of confidential information have steadily proliferated. In 2000 alone, more than 200 bills on privacy were introduced in the 106^{th} Congress of the United States (Hatcher, 2002). These measures aim at protecting individual rights and controls of personal data.

In design and training situations, instructional technology exacerbates the recognized confidentiality issues, some of which pertain to professional ethical conduct. For example, adult learners in training situations may feel pressured that their performance or level of competences would be divulged to their managers. The pressure is not imaginary as new types of technological software, such as expertise locators, can track every step of the use of online resources, assume a learner's interests and potential expertise based on his/her online activities, and categorize the individual within the organization (Mabry & O'Driscoll, 2003). Frequently, all this occurs without the acknowledgement of the learners.

Web Accessibility

A 1997 U.S. Census Bureau report indicated that 19.6% of the U.S. population has some sort of disability such as visual or hearing impairments (French & Valdes, 2002). It is clear that providing equal learning opportunities to people with disabilities is imperative. In 1996 the Justice Department stressed that the entities under the ADA are required to provide effective communication through print media, audio media, or such electronic media as the Internet (French & Valdes, 2002). In 2001 the accessibility requirements for U.S. electronic and information technology took effect under Section 508 of the Federal Rehabilitation Act, which is considered to be the ADA of cyberspace (Waddell & Thomason, 1998).

Other than laws that require Web accessibility, many agencies, from an ethical standpoint, have been contributing to the growth of Web accessibility to people with disabilities. For example, the World Wide Web Consortium (W3C) has earned international recognition for establishing guidelines and providing resources to the universal design of the World Wide Web. Web Accessibility in Mind (WebAIM) aims at improving accessibility to online learning opportunities for all people and, especially, helping people with disabilities who experience difficulty in getting access to post-secondary online learning opportunities.

These joint efforts have been appraised by researchers. Foley and Regan (2002) stressed that "accessibility is the right thing to do" (p. 66) because it gives people with a disability a broader range of employment and educational opportunities via innovative technology. French and Valdes (2002) echoed that "the sooner we create and implement sustainable solutions, the sooner ALL students can participate in their right to experience the power

of the Internet for lifelong learning" (p. 13). However, as Carnevale (1999) indicated, often those Web site creators of distance-education programs in higher education do not ignore the Web accessibility issue on purpose; rather, they don't always realize the importance of Web accessibility.

Diversity and Inequality

One challenge to our increasingly diverse society is the balance between those who have power and resources and those who have not. As Han (1994) contends, power gaps and inequality in society are "partly attributed to general apathy concerning ethics and disparity in sharing knowledge discovery between ordinary people and those holding power" (p. 1). Instructional technology, as a powerful tool to enhance knowledge acquisition and transform the global information infrastructure, can be used to achieve the goals of closing the power gaps as well as widening the gaps. Ideally, if technology-based learning is accessible to everyone, the resulting knowledge discovery is helpful in removing societal inequities. On the contrary, if technology-based learning is manipulated by someone who uses the power inappropriately, power gaps can be widened (Han, 1994).

Unfortunately, technology-based learning has seen limited use in "teaching diversity or developing societies based on equality" (Hatcher, 2002, p. 146). In other words, while technology empowers some to advance and reach potentials, it also reinforces traditional barriers to others. Professional technologists, as Hatcher (2002) suggests, should "be diligent in providing equal access to training and other technology-based, career-enhancing activities" (p. 145).

Technology-Based Learning

Technology-based learning seeks to "improve learning through the metaphor of 'instructional technologies'" (Hatcher, 2002, p. 146). However, certain ethical issues arise when technology-based learning is conducted. The first ethical issue is that available technology often overshadows learning needs or each new technology is used as a replacement for all existing learning methodologies (Piskurich & Sanders, 1998). In this sense, knowingly recommending or adopting unnecessary technologies is known as "technolust" (Bassi, Buchanan, & Cheney, 1997). Arguably, researchers suggest that an appropriate performance analysis, which emphasizes the analysis of performance gaps, learning needs, goals, and identification of the underlying causes of the problems, should be conducted to justify which technologies are the best fit and can supplement the intervention (Rossett, 1992; Rossett & Arwady, 1987).

The second ethical challenge for professional technologists relates to the awareness of the impact of their work on other people. The decisions to use or dispose of instructional technologies do not stand alone with the decision makers. Rather, as Mason (1995) points out, any changes in "hardware, software, information content, information flow, knowledge-based jobs, and the rules and regulations affecting information are among the many things agents do that affect others" (p. 55). For this reason, professional technologists should take into consideration their actions and take responsibility for the impact of their actions on other people.

Laws

Two laws in particular address copyright issues relating to the application of instructional technology. The first law is *The Digital Millennium Copyright Act of 1998.* This law outlines copyright issues and policy goals to protect intellectual property and the national information infrastructure. One of the most notable messages from the law is that it limits Internet service providers from copyright infringement liability for simply transmitting information over the Internet. (UCLA online Institute, 2004). The second important law is *The TEACH Act*, an acronym for Technology, Education and Copyright Harmonization Act. It was signed into law in 2002. The TEACH Act, as described by the American Library Association, was long anticipated by educators and librarians in that it "redefines the terms and conditions on which accredited, nonprofit educational institutions throughout the U.S. may use copyright protected materials in distance education -- including on websites and by other digital means -- without permission from the copyright owner and without payment of royalties" (the American Library Association web site).

The issues addressed by these two laws reflect a growing concern that has arisen as technological improvements have facilitated the transfer and use of information. The research question reflects this concern.

Research Question

What ethical issues associated with instructional technology do professional technologists report as having experienced in online course design and Web-based training situations?

Methodology

Subjects

Purposive sampling was used to recruit participants from three departments in a major Mid-Atlantic research university. Several criteria were used to recruit research participants from these units. The participants were required to have a minimum of two years of experience working with learning technologies in one of the following responsibilities: 1) designing and developing online courses, 2) providing instructional technology support to establish e-learning environment, and 3) incorporating learning technologies into training programs. The selection criteria ensured that the research participants had appropriate levels of experience in utilizing learning technologies from which to draw upon to discuss experiences in ethical situations.

After the directors of the three departments sent out an e-mail announcement, attached with my invitation letter, to their units' list serves to encourage their staff to contact me on a voluntary basis, a total of 20 professional technologists were recruited in this study. Their job titles primarily include instructional designers, instructional technologists, and technology trainers. Eighty percent of the participants were in the age group from 25 to 45 years; their experience working in learning technology ranged from 2 to 15 years. Ten participants were male, ten were female; twelve had an Adult Education/Instructional Systems/Training background.

Procedure

In-depth, face-to-face interviews were used to collect data. The advantage of in-depth interviews, as Van Manen (1990) indicated, is that a researcher, by conducting the interview, and reading and rereading the interview texts, can discover, literally "hear," the meaning of the lived experience from the experiencer's perspectives. After a pilot interview, the original interview guide was revised to improve the clarity of the questions. In its final form, the interview protocol consisted of seven open-ended questions with suggested probes and clarifications under each question. These open-ended questions asked participants to recall ethical issues associated directly with their work activities. The length of the interviews varied with an average session lasting about 40 minutes.

During the interviews, the interview guide was followed using a protocol that allowed for flexibility in the use of probes and clarifying questions. Since recalling ethical situations and being audio recorded might be stressful to some participants, all were assured throughout the process of the confidentiality of their responses. The interviews were conducted over a four-month period.

Data Analysis

All interviews were transcribed verbatim. Afterwards, data analysis for this study followed the constant comparison techniques that were described by Glaser and Strauss (1967) and Strauss and Corbin (1990).Two researchers (one author and one other person who was experienced in qualitative analysis but not involved in the study) independently read and coded the transcripts. Data analysis involved three phases**.** During the first phase, free and open-coding was used (Strauss & Corbin, 1990).This process begins by reading through the transcripts several times, immersing oneself in the data, underlining key words and phrases in the transcripts and making notes on each section of each transcription. These key words, phrases, and notes are the units of analysis that provide the groundwork for further analysis.

The second phase of the data analysis process engaged axial coding. This method uses a series of procedures that make connections within and between groupings and allows for new combinations of data (Strauss & Corbin, 1990). Using the condensed list that was developed in Phase 1, coders sought common and related concepts from the collection of instances documented in each grouping. Following the procedures of axial coding, we continued making connections and combining data within each grouping. During this process, some units of analysis were regrouped wherever necessary. Next, in Phase 3, coders examined and summarized core variables as themes and placed situations under appropriate themes. Using this approach, themes were generated and summarized for each research question.

Validity, Reliability and Objectivity

A synthesis of each interview was prepared and sent to the participant for content verification. All the participants replied and indicated that the syntheses had captured the essence of their interviews. Two people independently coded the transcripts and discussed and resolved differences. An audit trial—detailed field notes, memos, and notes--was maintained throughout the process. Two people not involved in the initial coding reviewed the analysis.

Results

The issues mentioned most frequently by the participants are found in Table 1.

Table 1. Summary of Ethical Issues Experienced by Professional Technologists

Issues	Number of Participants (n=20)	Percentage
Copyright	15	75%
Learner Privacy	13	65%
Accessibility	11	55%
Diversity	7	35%
Conflicts of Interest	4	20%
Professionalism/Confidence	3	15%

Out of 20 participants, fifteen mentioned copyright as a major ethical issue they had to handle in their daily work activities. Thirteen indicated that learner privacy is an ethical issue for them, and over half indicated accessibility as a major concern. For the first three issues, I give verbatim examples from the transcripts. For the last three, due to space constraints, I give only summaries.

Issue 1: Copyright

The most frequent ethical issue that learning technology practitioners have experienced is digital copyright. There are three situations in which learning technology practitioners encountered the copyright issue. The first situation was usually when practitioners, especially instructional designers and instructional technology specialists, interacted with faculty members and needed to communicate extensively with them about copyright clearance in order to design online materials. One study participant indicated:

> Copyright is a big issue in our day-to-day working. We also have requests from faculty members to use things without getting copyright clearance, like they might give us an image or they may want to be able to use a piece of text from the textbook. Explaining that we are restricted in what we can do is often a big topic of conversation (Participant 5).

The second situation regarding copyright was getting permission for an item to use in the work they were developing. This item could be a piece of text, a graphic, a Hollywood movie clip, or a music clip. In order to be able to use these items, practitioners had to obtain copyright clearance. One participant said:

> Our unit is heavily involved with making sure that anything we work with a project has copyright clearance, and that we have the right to use. We do a lot of development in house of things of our own. If we can't get copyright for something, we create things for ourselves to make sure that there are no copyright issues. We have that in all areas (Participant 4).

The third copyright situation was struggling to balance copyright and fair use. Specifically, a majority of 15 participants who mentioned copyright as an ethical issue also indicated that there was a gray area between copyright and fair use guidelines in their job. For example, a trainer who usually prepared seminar handouts and distributed them in free technology seminars in the university said:

> With training, I think the biggest ethical dilemma is whether information is copyrighted or not. For example, if you are teaching an Intro class for Microsoft, and a lot of time because of time, instructors including myself, we end up just copying and pasting the how-to-step-by-step from the HELP menus or from other materials […]. Is it OK to do this? I don't know…If I do use example files from another company, I always cite where I got that information […].I guess the guideline I use is in the classroom situations, and it is in the educational settings (Participant 8).

Another participant found it difficult to differentiate copyright and fair use in certain situations as well:

> There are times when you are trying to figure out just where the line is in the work. You know how close you are getting to the line where you are actually taking and not making different enough. And that's gray area. I mean we try the best we can to stay in the law, but also we had to try to get our work done, you know, get what we need to the courses (Participant 2).

Another participant commented on the gray areas of copyright issues:

> There is not a clear cut, black and white issue. There is a lot of gray area, you know, just what is allowed, what isn't. And you need to know a lot about every particular instance before you can say, well yes, I think you are right, I think you are not complying (Participant 18).

In general, the majority of participants who considered copyright an ethical issue found it difficult to differentiate between copyright and fair use guidelines. The question then becomes whether technology helps rid of the gray area or makes it more complex? One participant noted:

> I think technology has got a long way to go, and there are still a lot of answers to…who owns this? Who has the ownership in the creation of that material? Let's say I am in a team, and I am working on a project for a course I am working on. And I want to put this presentation report project, whatever it is we create as a team, in my portfolio. Well, who owns that project? Do I have to get permission from the other people in my team to publish that in my portfolio? And how do we check that? (Participant 19).

Considering that the Digital Millennium Copyright Act of 1998 makes copyright more of a legal issue, we decided to further delve into the ethical aspects of copyright: Is it an ethical issue or a legal issue? Unanimously, participants said copyright was both a legal and an ethical issue. Comments from several practitioners listed below can give us a glimpse on the ethical aspects of copyright issue. One participant said:

> It is both. You don't want to violate the law because it is law. On the other hand, I do believe that having done online work myself, I know how much work to the creation of those products. And I do believe that, creators have a right to earn some value of their work (Participant 13).

Issue 2: Learner privacy

With its swift expansion and growing popularity, information technology provides broad access to confidential resources (Pourciau, 1999). As a result, individual privacy and online confidential information are susceptible to being violated and abused. In this study, 13 participants cited that dealing with learner privacy was an ethical endeavor. One participant described how easily a learner's private information can be misused with technology:

> And it makes easy for almost anybody to use it. There might be online grade book that you could cut and paste it into an Excel and publish it into a report and show it on-line. Message board, you can take a snapshot of it and paste it to a PowerPoint presentation and take it to a conference, and never consider the fact that in that snapshot you also have student names, you have student data (Participant 5).

This participant continued to explain:

> Technology gives people a lot of capabilities that they might never have had before. And also along with that might open up possible opportunities for unethical behaviors that they may not even consider being ethical (Participant 5).

In training situations, the potential of disclosing trainees' private information to an unintended population can be an ethical issue to the participants. One participant described a situation in a training situation:

> The ethical kind of dilemma that we had is: when should we allow a staff member's supervisor to actually see their scores? So that I think it is probably kind of an ethical dilemma that we face. When was it OK to do it? Did we need to give their permission? How far over the line where we are stepping with the privacy? […] Because a staff member might not want their supervisor to know they are taking a lot of, you know, pretty detailed technology courses. For instance, if they are the office receptionist, or a secretary, and they are trying to move into web designer, or something. That person may not want their supervisor to know that they are planning on leaving because it might make their work environment a little awful for them. So that's something we had to deal with (Participant 10).

In general, technology makes individual privacy and confidential information accessible as well as vulnerable. In design and training situations, learner privacy can be violated in that learners' online activities can be tracked, and learners' private information, such as data and training scores, can be disclosed to an unintended population.

Issue 3: Accessibility

Accessibility seems to be a particular ethical issue for learning technology practitioners working in an educational setting. The participants emphasized that accessibility means that a product reaches not only to a majority of its end users, but more importantly, to a small amount of users who have special needs, such as people with disabilities. One participant put it simply:

> Every new web site we create, we try to make it as accessible as possible (Participant 6).

Another participant had similar concerns and provided more information:

> Whenever we promote something, we need to say in such a way that it is understandable, and it is relatable to all avenues of people and all sorts of life. Dealing with technological kind of function, you sort of speak in that language (Participant 14).

Speaking about accessibility as an ethical issue, one participant explained:

> Accessibility is very important. We try to make things accessible if it is presented online [...]. This is where we can get into discussion on ethics. How far do we go down those lines? Does it really have to be accessible? Is that technology versus accessibility? We can really do something cool if we don't care about accessibility, but we have to make sure it is 100% accessible (Participant 4).

In summary, the participants indicated that making materials being accessible to a wider array of learners was more important than being 'cool' or using fancy technology. They emphasized that ethically speaking, it was the right thing to be more conscious of people with special needs

Issue 4: Diversity

Seven participants also cited diversity as a major ethical issue in their work activities. They indicated that diversity was an ethical issue both in design and training situations. In design situations, the participants pointed out that they had to be very conscious about the impact of online materials on people from diverse backgrounds. To this end, they made sure that content that they designed and produced with learning technology **is** not only understandable and meaningful, but also respectful to all avenues of people and all sorts of life. In training situations, diversity being an ethical issue was not only about taking consideration of people's diverse backgrounds, it was also about not discriminating or stereotyping people when it comes to the use of technology, for example, discriminating against older people in seminars and workshops.

Issue 5: Conflicts of Interest

Technology training is taking place in many organizations on a daily basis. For this reason, people who have technological knowledge and skills are often outsourced by some external organizations. People who have access to computing resources are viewed favorably by external organizations as well. When learning technology practitioners take advantage of their skills and training materials that they developed on their work time to earn a second income, they potentially compete with their employer for business in an unfair way. Therefore, conflicts of interests occur. Four participants in this study recognized that they did experience conflicts of interest in their job, and that ethical decision making was involved

Issue 6: Professionalism/Confidence

The last ethical issue identified in the study, cited by three participants, was related to possessing sufficient credentials to perform confidently and professionally in design and training situations. The participants indicated that as technology skills become desirable in the workplace, many people from various disciplines and backgrounds suddenly engage in designing online materials or delivering technology training. Some practitioners may not have sufficient credentials to ensure quality of work.

Conclusions

In summary, six major ethical issues, in order of their frequency, were identified in this study: copyright, learner privacy, accessibility, diversity, conflicts of interest, and professionalism/confidence.

Among these ethical issues, copyright, learner privacy, and accessibility have often been discussed in the literature with a focus on their legal connotations. This study, however, found that in online course design and Web-based training settings, these issues develop ethical ramifications beyond their usual legal consequences.

This study also identified three ethical issues that have not been discussed extensively in the literature: diversity, conflicts of interest, and professionalism/confidence. First, the identification of diversity as an ethical issue enriches the current literature. Previously, researchers proposed that the introduction of instructional technology can widen or close the inequality gap among different people and groups (Han, 1994; Hatcher, 2002). The results of this study suggests that diversity is an ethical issue in that professional technologists, who have a wide range of technical skills, can create learning materials that exclude people from diverse backgrounds and stereotype learners. Conflict of interest is another ethical issue that has not received adequate attention in the literature. The results of this study enrich Marby and O'Driscoll's (2003) discussions of how professional technologists use their knowledge and output outside of the scope of their jobs as well as identifying a few sources of conflicts of interest: taking learning materials developed on work time outside of the scope of work, taking advantage of the current position to earn a second income in other organizations, and using public resources for personal gain. The last ethical issue that is underrepresented in the literature is professional technologists' professionalism and confidence in performing their work. The study found that it is unethical if professional technologists produce work of poor quality that results from only having knowledge and skill sets in either educational principles or technology applications.

This study did not support several ethical issues that have been addressed in the literature. One issue is related to power and inequality, in which technology-based, career-enhancing activities can be accessed only by those who have power and resources. Another issue that is not supported by the study is the misuse of instructional technology. For example, if professional technologists overuse available technologies, they tend to ignore customers' learning needs and replace existing learning methodologies.

Recommendations

As professional technologists face both possibilities and problems in the use of instructional technology, the identification of ethical issues is important to help establish effective guidelines for practice. With this understanding, our research and practice should be sensitive to not only who we are, but what we do, and why we do as professionals (Schwier, 2005).

For Researchers

The results of this study lay the groundwork for future study. Future research can continue to identify the ethical issues and coping strategies that help yield a clearer picture of ethical issues that professional technologists have experienced. Such information will be beneficial not only to our understanding of the ethical issues in the use of instructional technology in design and training situations, but also to help management provide possible strategies to handle these issues. Future studies can also be extended to investigate the nature of instructional technology, its maturity, and the assumptions that drive the technology by comparing our work with that of related professions (Schwier, 2005; Waters & Gibbons, 2004). Moreover, future studies can use different methodologies to investigate ethical issues and coping strategies such as quantitative methods or responses to hypothetical cases. Finally, future studies can explore the role of organizations and management in addressing ethical challenges posed to professional technologists.

For Managers

As the study revealed, the majority of the participants stated that they found it difficult to differentiate between copyright and fair use guidelines in educational settings. As a result, it is advisable that management not only covers copyright laws or guidelines, but also includes materials that apply these laws and guidelines to a collection of previous ethical situations. Another recommendation for management is to develop and implement a system for the reporting of ethical issues that have been encountered by professional technologists. Information from the reporting system can provide excellent cases that could be used to develop in-depth and skills-oriented seminars. Such information could also be used in employee orientations to socialize new professional technologists into the organization. Finally, as the findings in this study indicated, professional technologists turned to their team members and managers frequently for checks and balances when they were faced with ethical issues. Consequently, management should foster the two-way free flow of communication, which not only facilitates a smooth workflow, but also encourages informal sharing of the best practices of handling ethical situations.

For Practitioners

The results of this study also yield several recommendations for professional technologists. In relation to ethical issues, one of the first steps that a professional technologist can take is to locate relevant seminars, resources,

and experts in their organizations. They can also network with other practitioners in the field to share experiences so that their managers are not their sole source of reference. Ultimately, the professional technologists' job should not only be limited to incorporating technology and instructional models into their complex array of responsibilities, but should also be extended to the awareness of the values they hold and the ability to use these values to inform practice. After all, similar to other professions, applications of instructional technology is not about a technical act; it is a process that includes moral and political consequences as a result of our choices for action (Schwier, 2005). Understanding the ethical implications of our choices will give us a grounding as we practice our craft.

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Learning "Pragmatics" On-line Through Partnership: A Cross-Cultural Study between Taiwanese College Students and Their Texan Tutors

Chia-Ning Jenny Liu
Texas A&M University

Yi-Chuan Jane Hsieh
Ching-Yun University

Zohreh Eslami-Rasekh
Lauren Cifuentes
Texas A&M University

Abstract

This study investigated the effectiveness of the use of Computer-Mediated Communication (CMC) in learning pragmatics. The impact of teaching pragmatics by E-mail and WebCT discussion on Taiwanese EFL learners' pragmatic competence was explored. Relative effectiveness of learning pragmatics through in-class activities and telecommunication were also compared. Data collected in school settings were analyzed quantitatively and qualitatively. The results showed that the pragmatic instruction enhance EFL learners' pragmatic competence.

Background and Theoretical Perspective

Since the adoption of the communicative approach in second or foreign language teaching, more importance is given to the achievement of functional abilities in the target language. The development of second language pragmatic competence involves the ability to appropriately use a wide range of speech acts such as "greeting," "apologizing," "complimenting," and "requesting." Among them, requesting, the focus of pragmatics instruction in this study, has been one of the most studied speech acts. Various studies have also indicated that requesting is one of the most frequently used speech acts in communication (Ellis, 1992; Rintell & Mitchell, 1989; Rose, 1999).

There is a general agreement that pragmatic knowledge in the second language can be acquired by utilizing universal pragmatic knowledge, and some aspects from the learner's first language can be transferred to the second language. However, Bialystok (1993) has reported that in order to acquire processing control over the existing pragmatic foundations, adult second language or foreign language learners need to develop new representations of pragmatic knowledge not existing in their first language. In addition, research has shown that many aspects of pragmatic competence cannot be acquired without a focus on pragmatics instruction (Kasper, 2000). Therefore, it is reasonable to suggest that foreign language learning can be aided by instruction which helps learners practice their linguistic knowledge in communicative activities.

In spite of existing theory and research evidencing the need for pragmatics instruction, English-as-a-Foreign Language (EFL) classrooms mainly focus on grammar-oriented instruction and pragmatic development of language learners has been overlooked. Studies have examined the fact that when pragmatics is not a planned subject in a second or foreign language classroom, the opportunities for developing pragmatic competence is quite limited (Kasper, 2000). The consequence is that English language learners who have studied English for years still face problems using language appropriately in communicative contexts.

In addition, learning English is rather difficult in an EFL learning environment compared to an English-as-a-Second-Language (ESL) environment because EFL learners do not have the opportunity to interact with native speakers of the target language as ESL learners do. Language class activities in EFL settings often focus on decontextualized language practices, which do not expose learners to the types of sociolinguistic input that would facilitate pragmatic competence acquisition.

Recently, interventional studies have examined the effects of explicit instruction in pragmatic competence on the development of learners' pragmatic competence. The results from these studies have indicated the positive effect of pedagogical intervention, and this supports the view that pragmatic ability can be developed through

planned classroom activities (Bouton, 1994; Eslami-Rasekh, 2005; Rose, 1999; Takahashi, 2001; Tateyama, 2001). Studies conducted by Eslami-Rasekh (2004), Kasper (1997), Rose (1999), Takahashi (2001), and Tateyama (2001) also suggest that pragmatic features can be effectively acquired through explicit instruction on pragmatics.

Over the past two decades, computers have become common instructional tools in the ESL/EFL classrooms. Currently, collaborative e-mail exchanges are one of the instructional tools used in classrooms. Studies have shown computer-mediated communication (CMC) has many merits in classroom settings. Computer-mediated communication refers to interaction via telecommunications. Electronic communication has been found to have a number of beneficial features that make it a good tool for language learning. Research has indicated electronic communication can enhance students' motivation (Warchauer, 1996), and improve writing skills (Cononelos & Oliva, 1993). Cifuentes and Shih, (2001) further stressed that CMC provided an authentic context for learning functional abilities by having EFL learners interact with English-as-a-first-language speakers. With explicit instruction in how to communicate in the virtual environment, CMC may benefit the intercultural teaching and learning (Shih and Cifuentes, 2003).

Objectives

This study investigated the impact of pragmatic instruction on Taiwanese EFL learners' development of pragmatic competence. Relative effectiveness of learning pragmatics through in-class activities and telecommunication were also compared. The present study attempted to answer the following research questions: (a) Did students who received the in-class explicit pragmatic instruction improve their pragmatic competence more than those who did not do so? (b) Did students who received the explicit pragmatic instruction through telecommunication connection from Texan tutors improve their pragmatic competence more than those who did not do so? (c) What was the relative effectiveness of learning pragmatic through CMC as compared to in-class pragmatic instruction? (d) What were students' perceptions of learning pragmatics?

Methodology

This study applied a pretest-posttest control group experimental design and combinations of quantitative and qualitative data collection and analyses. The independent variable was the treatment with three different levels—(1) the control group which received no explicit pragmatics instruction, (2) the experiential in-classroom group which received explicit pragmatic instruction face to face from their classroom instructor, and (3) the experimental CMC group which received explicit pragmatics instruction from their Texan tutors through CMC (e-mail and WebCT discussion). The dependent variables were students' pragmatic competence.

Participants

Participants were 82 undergraduate students majoring in applied foreign languages from a university of technology in Northern Taiwan. The other 13 participants were graduate students majoring in teaching English as a second language at a university from Southern Texas.

In Taiwan, 82 students belonged to three intact classes and enrolled in the class of "English for Tourism." Because of institutional constraints, it was not possible to assign students randomly to the different groups, thus making it necessary to work with three intact groups. In an effort to determine equivalence of the three groups in terms of their English language proficiency, the *General English Comprehension Test* was given to the participants. The statistics results showed that the control group produced higher mean scores on the reading comprehension pretest ($M=31.067$, $SD=8.183$) than the experimental in-classroom group ($M=28.957$, $SD=7.258$) and the experimental CMC group ($M=28.966$, $SD=8.011$). Nevertheless, three groups did not differ significantly from each other in the performance of the reading comprehension pretest ($F=0.68$, $df=2$, $p=0.51$).

There were 30 students in the control group, 23 in the experimental in-classroom group, and 29 students in the experimental CMC group. In Texas, each of the 13 graduate students was randomly assigned to be the tutor for two or three Taiwanese experimental group participants. These students interacted with their Taiwanese learners through email correspondences and WebCT discussion. All Texan participants received the instruction as part of their curricular activities in the class.

Procedure

During the duration of this study (ten weeks), all eighty-two Taiwanese participants met once a week for one hundred minutes each time. At the beginning of each class, the professor in Taiwan spent fifteen minutes in dealing with class management and students affairs issues. Since the eighty-two Taiwanese participants were enrolled in "English for Tourism", participants in all three groups were engaged in the following warm-up tasks: watching a short film about tourism in English for about fifteen minutes, followed by instructors' explanation about film for about twenty minutes in each meeting. The instructor used the text book entitled: "At your service: English for the travel and tourist industry". Each week, the instructor taught one unit of the textbook.

During the remaining fifty minutes of the class, participants in the control group did not engage in any explicit pragmatics activities. Instead, the instructor spent about thirty minutes of lectures on learning tourism English using the teacher's manual as a guide, followed by twenty minutes of summary and discussion in each meeting for a total of fifty minutes. During the thirty minutes of lectures, students had the opportunity to interact with the instructor through questions and answers. And students also had small group discussion with their peers during the twenty minutes of summary and discussion. Participants practiced their English in terms of writing, listening, reading and speaking during class.

In contrast to the control group, during the remaining fifty minutes of the class, ten weeks lesson plans were delivered to the participants in the experimental groups; i.e., in-classroom and CMC. Each lesson plan consisted of one activity and each activity was designed in order to raise students' pragmatic awareness. The content for both groups are identical and was based on the ten weeks lesson plans developed by the researcher. The components of the lesson plans aimed to raise students' pragmatic awareness and offer learners the opportunity for communicative practice. For the experimental-in-classroom group, the lesson plans were delivered by the instructor through face to face mode; for the experimental –CMC group, the lesson plans were delivered though email correspondences and Webct discussion between Taiwanese students and their tutors.

At the beginning of the study, all students were asked to complete the Discourse Completion Task (DCT) pretest. Students in the control group received the regular classroom instruction that did not explicitly address pragmatics in the teaching contents. The experiential in-classroom group received explicit pragmatic instruction face to face from their in-classroom instructor, and the experimental CMC group received explicit pragmatics instruction from their Texan tutors through telecommunication (e-mail and WebCT discussion).

Following ten weeks of treatments, all students were asked to take the Discourse Completion Task (DCT) posttest. At the end of the study, the experimental CMC group took students' perceptions of learning pragmatics survey to explicate their attitudes toward learning pragmatics, attitudes toward using e-mail and WebCT in learning, and perception of learning from Texan tutors.

The Discourse Completion Task (DCT) included twelve situations with a special focus on speech act function of request. These situations were designed to probe how participants respond in different situation in terms of social status, power, and impositions. The social contexts specified in the DCT contain relationships between a professor and a student, a boss and an employee, and among friends. The purpose of this design was to see how participants interacted or responded to certain situations from different points of view. Two native English speakers rated the participants' Discourse Completion Task (DCT) pretest and posttest productions. The rating system used in this study was adapted from the rating system proposed by Hudson, Detmer, and Brown (1995), containing components as the followings: (1) the ability to use correct speech acts, (2) expressions, (3) the amount of information, (4) levels of formality, (5) levels of directness, and (6) levels of politeness. In this case, the last three components were combined as one (levels of politeness) due to the overlapping elements of speech existing among these three components. The raters rated participants' performance based on 5 point rating scale ranging from 1 to 5. The value for interrater reliability was reached to an acceptable level of agreement (r □.90).

Results

The descriptive statistics results of the DCT pretest scores by group are demonstrated in Table 1. There were four scores, including the score of the ability to use correct speech act, the score of expressions, the score of the amount of information, and the score of levels of politeness. The two experimental groups overall yielded higher mean scores than the control group against three rating components (expressions, information, and politeness). However, the experimental in-classroom group scored slightly lower in the speech act rating component as compared to the relative means of the control group and the experimental CMC group. In this case, there was no significant group effect for the DCT pretest; namely, three groups did not differ in their pragmatic abilities in the speech act function of request prior to the treatment (F=2.131, df=2, p=0.126).

Table 1: Descriptive Statistics Results of the DCT Pretest Scores by Group

Rating Components		Groups		
		Control (N=30)	In-Classroom (N=23)	CMC (N=29)
Speech act	Mean	46.00	45.70	48.45
	SD	5.92	5.65	4.63
Expressions	Mean	42.74	44.09	45.79
	SD	5.77	4.70	3.89
Information	Mean	45.28	46.45	47.00
	SD	5.58	4.72	4.53
Politeness	Mean	44.83	47.09	48.07
	SD	5.76	4.65	5.32

After treatments, the group comparison of the DCT posttest scores was conducted. The descriptive statistics results indicated that there existed greater discrepancy among the group means. The performances of the experimental in-classroom group and the experimental CMC group were better (surpassing from 2.7 points to 7.4 points) than those of the control group in each of the four rating elements (See Table 2).

Table 2: Descriptive Statistics Results of the DCT Posttest Scores by Group

Rating Components		Groups		
		Control (N=30)	In-Classroom (N=23)	CMC (N=29)
Speech act	Mean	45.07	48.32	52.45
	SD	4.43	4.83	4.44
Expressions	Mean	40.52	45.82	47.66
	SD	5.00	4.60	4.52
Information	Mean	45.11	47.82	50.10
	SD	3.69	5.01	4.24
Politeness	Mean	45.19	48.73	50.83
	SD	4.39	5.49	4.55

The repeated measures MANOVA results further showed that there was a significant difference among three groups on the four means of the DCT posttest (F=16.35, df=2, *p*<.05). The results of Tukey Honestly Significant Difference (HSD) Post Hoc test informed that the experimental in-classroom group and the experimental CMC group both scored significantly higher than the control group on the DCT posttest; whereas, the students in the experimental CMC group performed as well as those students who were in the experimental in-classroom group. Moreover, an interaction effect of the group by the four rating elements of the DCT posttest was found to be significant (F=2.93, df=6, *p*=0.009).

Figure 1 demonstrated the scores on expression yielded by three groups were significantly lower than the scores of other components (speech act, information, and politeness). The students in the experimental CMC group scored higher in the four rating components than the experimental in-classroom group, though difference was not significant. The control group produced significantly lower scores in all four rating components when compared to the two experimental groups. The experimental CMC group was found to have the highest mean scores on the speech act rating component, revealing their superior ability to use correct speech act than other elements necessary to make appropriate requests.

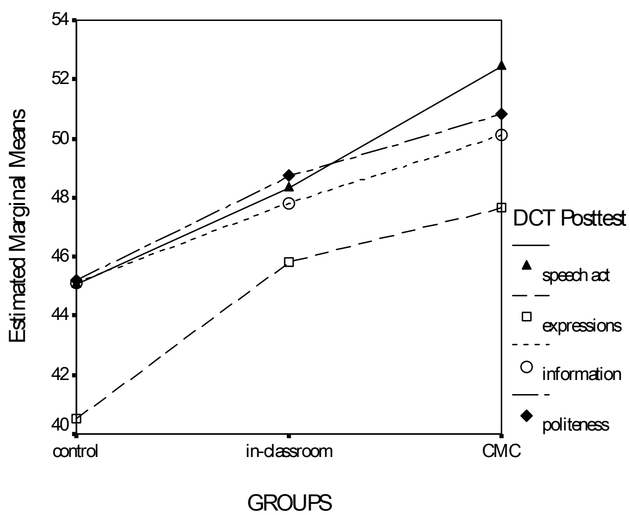

Figure 1. The interaction effect of the group by the four rating elements of the DCT posttest

After ten week conventional pragmatic instruction, the experimental in-classroom group showed significant improvement in their DCT productions. Overall, the experimental in-classroom group generated significantly higher scores on the DCT posttest than the DCT pretest (F=11.156, df=3, *p*<.05); the means for each rating component on the DCT posttest demonstrated an apparent increase, ranging from 1.37 to 2.62 points (See Table 3).

Table 3: Descriptive Statistics Results of DCT Pretest and Posttest Scores for the Experimental In-Classroom Group

Rating components	Tests	Mean Scores	Standard Deviation
Speech act	pretest	45.70	5.65
	posttest	48.32	4.83
Expressions	pretest	44.09	4.70
	posttest	45.82	4.61
Information	pretest	46.45	4.72
	posttest	47.82	5.01
Politeness	pretest	47.09	4.65
	posttest	48.73	5.49

Furthermore, as Figure 2 showed the scores on expression yielded by the experimental in-classroom group remained the lowest scores whether on the DCT pretest or posttest. The experimental in-classroom group was found to have the highest mean scores on the politeness rating component; that is, participants tended to show diverse levels of politeness while making requests. Meanwhile, the mean scores on the speech act rating component displayed the greatest improvement from the DCT pretest to the DCT posttest ($M_{DCT\ pretest}$=45.70, $SD_{DCT\ pretest}$=5.65; $M_{DCT\ posttest}$ =48.32, $SD_{DCT\ posttest}$=4.83). Other than that, the mean scores on expressions, the amount of information, and levels of politeness also fairly improved after the treatment.

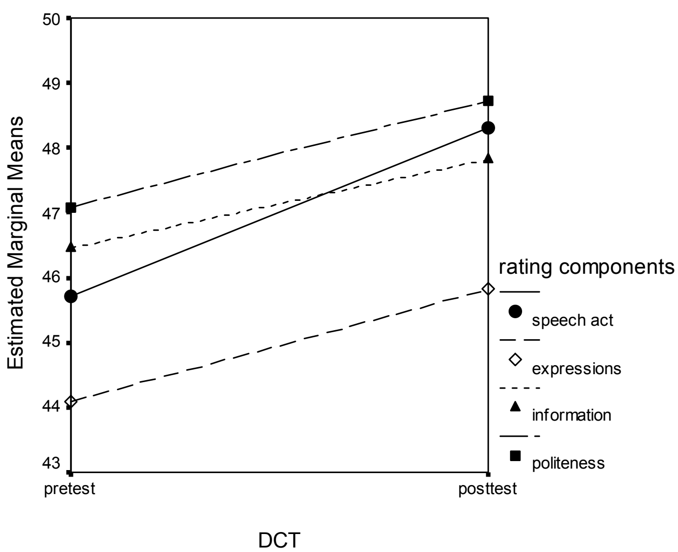

Figure 2. The DCT pretest and posttest scores by the four rating elements for the experimental in-classroom group

On the other hand, with ten week telecommunication connection to the Texan tutors, the experimental CMC group learned pragmatics through e-mail and WebCT discussion. The repeated measures MANOVA results showed a significant improvement of DCT productions for the experimental CMC group. Overall, the participants in the experimental CMC group generated significantly higher scores on the DCT posttest than the DCT pretest (F=47.897, df=3, p<.05); the means for each rating component on the DCT posttest increased ranging from 1.87 to 4 points.

Compared with the performances in the DCT pretest, the experimental CMC group produced significantly higher scores (p<.05) on the DCT posttest in terms of four rating components. The mean scores on speech act displayed the greatest improvement from the DCT pretest to the DCT posttest ($M_{DCT\ pretest}$=48.45, $SD_{DCT\ pretest}$=4.63; $M_{DCT\ posttest}$ =52.45, $SD_{DCT\ posttest}$=4.45) (See Figure 3). Other than that, the mean scores of the amount of information, levels of politeness, and expressions also fairly improved after the treatment.

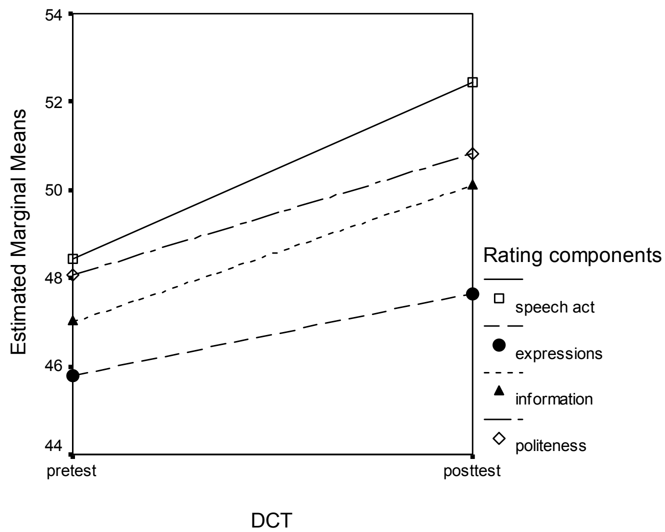

Figure 3. The DCT pretest and posttest scores by the four rating elements for the experimental CMC group

Students' Perception s of Learning Pragmatics On-line

Students from the experimental CMC group mostly expressed that the explicit pragmatic instruction indeed helped them gain more knowledge in English pragmatics. Compared to the content presented in the conventional English reading or writing textbooks, the content of this pragmatic instruction was more practical and useful for their daily communication. For example, one student stated that he did not know the accurate meaning of "You rock" until his Texan tutor explained it to him. "You rock" in the United States meant "You are so cool", and this student was pleased to learn more daily idiomatic expression in certain situations from his tutor. Another student also mentioned that he was strongly aware of the differences between Chinese and English pragmatics from communicating with his Texan tutor, and he regarded this learning experience as a valuable one because he hardly had the opportunity to interact with foreigners.

Another student shared that the pragmatic instruction was beneficial to her for it helped her to make appropriate requests in the airport while traveling aboard. This student looked forward to learning more content with higher level of difficulty and more in depth because she thought the learning of pragmatics was quite useful and important.

After ten weeks treatment, students in the experimental CMC group addressed that they enjoyed learning pragmatics by presenting examples for them in the first place, and then until they completely understood the content, they could use more examples to strengthen the concepts.

Nevertheless, more than half of the students in the experimental CMC group responded that some English words and phrases used by their Texan tutors were not readily understandable; they had difficulty figuring out the meanings of certain messages. Several students in the experimental CMC group expected their Texan tutors to be more patient and affectionate.

Students also reflected that the content of pragmatic instruction could be more situational, more animated with graphs, sounds, or short movies. A majority of students thought that the design of the content in the homework needed to be improved. The classroom instructor or Texan tutors should avoid posting similar and ambiguous questions every week, which bored the Taiwanese participants.

One student pointed out that he felt frustrated, and exhausted when asked to write and type short formal essays independently per week, which was more like taking a formal serious English composition class. It was hoped that the content could be displayed from the easier level to progressively go up to the difficult level.

Even so, most participants in the experimental CMC group were aware of the importance of pragmatics, and they realized that English was not as difficult as they thought before. They felt this learning experience was challenging, but interesting. It helped them gain more knowledge regarding Western people's thinking patterns and writing styles. In addition, they also felt more comfortable when they used English to perform requests in contexts.

Educational Significance

We found the pedagogical intervention had a positive impact on Taiwanese EFL learners' development of pragmatic competence from this study. With the appropriate classroom management and the Internet access of computers, the students in the experimental in-classroom group and the experimental CMC group had the opportunity to engage themselves in the process of learning pragmatics.

Additionally, computers functioned as "cognitive tools" for the experimental CMC group students to reflect, refine, and assess their structural knowledge. The findings of this study urge educators to integrate technology in helping Taiwanese EFL learners build up expertise in how to use English language appropriately, so that they can develop the ability to comprehend and generate productive communicative acts.

It was apparent that the Taiwanese EFL learners did not naturally think and write in English. Accordingly, the Taiwanese students required more time to process the English textual information and to respond in English. If they were given more time on tasks, they might feel less concerned and threaten, and became more responsible for their own learning.

Taiwanese EFL learners indeed need additional activities that can broaden their knowledge of pragmatics, and provide a broader variety of models and opportunities for them to supplement classroom setting of learning. We concluded that more complementary activities for EFL learners should be included in classroom settings, so that they can be given the opportunity to gain pragmatic knowledge. When pragmatics is explicitly taught to second language learners, they can acquire the essential skills faster (Bouton, 1994; Eslami-Rasekh, 2004).

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An Investigation of the Effects of Multimedia Research on Learning and Long-Term Retention in Elementary Math: A Research Agenda

Yuliang Liu, Ph.D.
Southern Illinois University Edwardsville, Illinois

Abstract
This paper first identifies that there is an underachievement in math nationwide as well as an underutilization of research principles from cognitive science in math curriculum and instruction. Then the paper provides a compelling rationale addressing the theoretical foundation and relevant prior empirical evidence supporting the proposed project. Finally, the paper provides the significance of the proposed project.

1. Identify the Education Problem That Will Be Addressed by the Project

(1) Underachievement in math

Current levels of math achievement at the elementary and secondary levels within the U. S. suggest that we are neither preparing the general population with levels of math knowledge necessary for the twenty-first century workplace, nor producing well prepared students to meet national needs for domestic scientists and mathematicians (Research & Policy Committee of the Committee for Economic Development, 2003; U.S. Department of Education, 2003a, 2003b, 2003c). Despite the fact that levels of math achievement have improved over the past decade, achievement gaps continue to exist. Further, low levels of achievement are more likely to be present among minority groups and students from low-income backgrounds (U.S. Department of Education, 2003a). This underachievement in math may be related to math anxiety that is formulated in the later elementary grades (grades 3-6) with increasing exposure to events or significant others such as teachers and friends who solidify the anxiety (Hackworth, 1985). Additionally, there has been much debate regarding what constitutes math proficiency and which teaching methods support student achievement of this proficiency. Limited empirical research has been conducted to compare these instructional approaches to determine what leads to improved math achievement across ethnic and socioeconomic groups in the U.S.

(2) Underutilization of research principles from cognitive science in math

According to Carver and Klahr (2001), cognitive scientists have identified numerous basic principles of learning that are supported by empirical research in traditional, well-controlled laboratory settings. In math, over the past 20 years, cognitive and developmental researchers have described the growth of young children's scientific knowledge and numeracy (e. g., Kalchman, Moss, & Case, 2001; Lehrer, Schauble, Strom, & Pligge, 2001; Palincsar & Magnusson, 2001). However, for the most part, curriculum in math has not widely or systematically incorporated findings from this accumulation of research either through the creation of materials that support teaching and learning or at the level of instruction. Furthermore, little work has been conducted to evaluate the effectiveness of math curricula and instructional practices for improving student learning and achievement (Glaser, 2001).

The three components of cognition (attention, memory, and reason) are the basis for achievement in math and other academic areas. Many scholars have called for research to bridge the gap between detailed, rigorous models of attention and successful academic performance (Baddeley, 1990; Carver & Klahr, 2001; Glaser, 2001; Hitch & Logie, 1996). Recent discoveries about multiple memory systems and their underlying neurological processes hold particular promise for developing instructional methods that tap into implicit learning (Baddeley, 1990, 1999; Carver & Klahr, 2001; Hitch & Logie, 1996). Thus research is needed regarding how to improve the encoding of information and retrieval of implicit memories for learned material, how memory representations can better reflect what has been taught, and how the flexible use of memory systems can facilitate accurate reasoning and problem solving.

2. Provide a Compelling Rationale Addressing the Theoretical Foundation and Relevant Prior Empirical Evidence Supporting the Proposed Project

(1) Provide a compelling rationale addressing the theoretical foundation

According to Bork (1992), a multimedia learning environment is a new paradigm for learning in current education. This is especially true for math learning. According to Tooke (2001), “The computer affected mathematics education. It changed the mathematics curriculum, the teaching of mathematics, and even the way mathematics was learned,”(p. 1). But investigating the effects of computer-based multimedia on learning and performance requires a solid foundation in cognitive psychology and learning theory (Astleitner & Wiesner, 2004; Dijkstra, Jonassen, & Sembill, 2001; Mayer, 2001; Rouet, Levonen, & Biardeau, 2001; Sweller, 1999). Multimedia scholars have recently built their research on cognitive learning theory (e. g., Bishop & Cates, 2001; Schnotz, 2001; Wright, 2001). In addition, Mayer’s recent work of multimedia investigations are heavily grounded in cognitive

theory (Mayer, 1997, 1999; Mayer & Anderson, 1991, 1992; Mayer, Bove, Bryman, Mars, & Tapangco, 1996; Mayer & Gallini, 1990; Mayer, Heiser, & Lonn, 2001; Mayer, Mayer, Sims, & Tajika, 1995; Mayer & Moreno, 1998; Mayer, Moreno, Boire, & Vagge, 1999; Moreno & Mayer, 1999, 2000a, 2000b, 2002).

Mayer (2001) based the majority of his recent multimedia work on an integration of Sweller's cognitive load theory (1988, 1999), Paivio's dual coding theory (Clark & Paivio, 1991; Paivio, 1986), and Baddeley's working memory (WM) model (Clark & Paivio, 1991; Paivio, 1986). Mayer focuses on the auditory/verbal channel and visual/pictorial channel. Mayer establishes his cognitive theory of multimedia learning through the following model (p. 44).

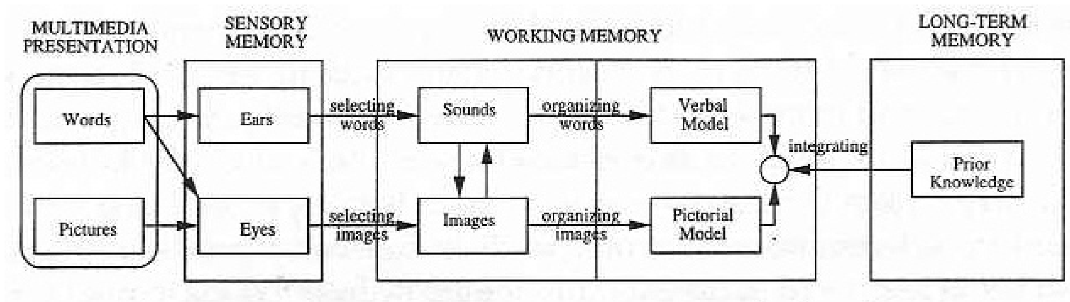

Figure 1. Mayer's (2001) Cognitive Theory of Multimedia Learning

This model is based upon three primary assumptions: (a) Visual and auditory information is processed through different information processing channels. (b) Each channel is limited in its ability to process information. (c) Processing information in different channels is an active cognitive process designed to construct coherent mental representations. Furthermore, this model is activated through five steps: "(a) selecting relevant words for processing in verbal working memory, (b) selecting relevant images for processing in visual working memory, (c) organization of selected words into a verbal mental model, (d) organizing selected images into a visual mental model, and (e) integrating verbal and visual representations as well as prior knowledge," (Mayer, 2001, p. 54).

According to Mayer (2001), multimedia design is a potentially powerful system for enhancing human learning. The two approaches to multimedia design are: technology-centered approach and learner-centered approach. The technology-centered approach typically starts with the functional capabilities of multimedia and focuses on the incorporation of multimedia into emerging communication technologies. According to recent research (e. g., Cuban, 1986; Cognition and Technology Group at Vanderbilt, 1996a), the technology-centered approach does not usually lead to durable improvements in education. Thus scholars in multimedia research have focused on another important theoretical alternative--the learner-centered approach. The learner-centered approach typically starts with how the human mind processes information and focuses on how to use multimedia technology as an aid to enhance human cognition and learning. The learner-centered approach supports the idea that humans process information more effectively if the multimedia design is consistent with the way the human mind works.

Based on Mayer and colleagues' recent studies, Mayer (2001, p. 184) proposed seven multimedia design principles: (a) Multimedia: Students learn better from two or more types of media such as words and pictures rather than from words alone. (b) Spatial Contiguity: Students learn better when corresponding words and pictures are presented close to each other rather than far apart on the page or screen. (c) Temporal Contiguity: Students learn better when corresponding words and pictures are presented simultaneously rather than successively. (d) Coherence: Students learn better when extraneous words, pictures, and sounds are excluded rather than included. (e) Modality: Students learn better from animation and narration than from animation and on-screen text. Thus multimedia presentations involving both words and pictures should be created using auditory or spoken words, rather than written text to accompany the pictures. (f) Redundancy: Students learn better from animation and narration rather than animation, narration, and on-screen text. Thus multimedia presentations involving both words and pictures for the same content should present text either in written form or in auditory form, but not in both. (g) Individual Differences: Design effects are stronger for low-knowledge learners than for high-knowledge learners, as well as for high spatial learners rather than for low spatial learners. In all, this model provides instructional designers with a summary of main factors that have to be considered when developing multimedia-based learning environments (Astleitner & Wiesner, 2004). Many other cognitive researchers (e. g, Kumpulainen, Salovaara, & Mutanen, 2001; Leahy, Chandler, & Sweller, 2003) also suggest focusing on the design of instructional situations and pedagogical supports for multimedia-based learning.

Recently many multimedia scholars have suggested that all courses be redesigned on a national or international scale based on the characteristics of the multimedia environment (Bork, 1992; Confrey, 1996; Cuoco & Goldenberg, 1996). However, systematic multimedia integration into the current math instruction has yet to be integrated in the schools (e. g, Neuwirth, 2002; Robertson, 1998). The creation and development of a multimedia version of current elementary math curricula will follow Mayer's (2001) multimedia design principles described previously. All content areas in the elementary math curriculum will be examined for adding appropriate multimedia components. The design and development of such multimedia curriculum will be based on the principles and standards for school mathematics from the National Council for Teachers of Mathematics (NCTM, 2000). The project will also be based on the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model (Dick, Carey, & Carey, 2001). The ADDIE model includes five components: (a) Analysis: Including analyzing the elementary students' characteristics, learning tasks, and environments. (b) Design: Including writing course objectives, developing course outlines, and determining effective multimedia delivery methods for each content chapter. (c) Development: Including writing course content by integrating multimedia (e. g., video clips, animation) and sound into math instruction, such as content presentations, readings, activities, and assessments. (d) Implementation: Including delivering the multimedia instruction to the experimental student. (e) Evaluation: Including formative weekly or unit evaluation that is used to improve instruction during the multimedia instruction every week and yearly summative evaluation that measures the overall effectiveness of the course at the end of each semester and/or academic year.

(2) Provide relevant prior empirical evidence supporting the proposed project

The study of technology improving learning in the classroom is a debatable one, due to the relative novelty of using technology in an educational setting. In evaluating the effectiveness of technology on students' cognition and learning, several factors must be considered. These factors include things such as the goal of the instruction and the information presented, the type of technology used, the implementation and use of the technology by the educator, and the students' personalities. Most studies have found that these factors must be considered in order to determine if technology improves learning (e. g., Arnone, 2003; Baker, 2000; Barton, 1998, 2002; Schwartz & Beichner, 1999).

Mayer's (2001) seven multimedia design principles (described previously) are consistent with the proposition described in the above paragraph. Based on Mayer's seven multimedia design principles, Mayer and colleagues have conducted a series of studies investigating the nature and effects of multimedia presentations on human learning for the past decade. According to Mayer, there are two basic goals of multimedia learning. The first goal is to remember information. This refers to the ability to recall, recognize, or reproduce information presented. This goal focuses on retention of acquired information. The second goal is to understand information. This refers to the ability to apply acquired information to novel situations. This goal focuses on transfer of the acquired information.

Based on Mayer and colleagues' recent multimedia research, Mayer (2001) proposed three possible types of multimedia learning outcomes: (a) no learning at all, (b) rote learning, and (c) meaningful learning. In meaningful learning, students will learn integrated knowledge and exhibit good performances in both retention and transfer. Mayer and colleagues focused on investigating the effects of multimedia presentations on college students' cognition and learning. Mayer further summarized the empirical evidence based on retention and transfer tests that he and his colleagues administered in their research. With the exception that no differences were found regarding the temporal contiguity effect for retention between both experimental and control groups, the effects of all principles were better for both retention and transfer in the experimental group than in the control group (p. 185-186).

Recent limited studies have found that multimedia has a positive impact on learning across K-12 educational settings (e. g., Felix, 1998; Gouzouasis, 1994; Khalili & Shashaani, 1994; Maddux, Johnson, & Willis, 2001; Najiar, 1996; Scarlatos, 2002; Wenglinsky, 1998). These effects have been found in a variety of school subjects such as math (Mikk & Luik, 2003), reading (Heimann, Nelson, Tjus, & Gillberg, 1995; Passig & Levin, 2000), geoscience (Chang, 2004), biology (Koroghlanian & Klein, 2004), instrumental education (Orman, 1998), as well as for special education students such as autistic students (Heimann, Nelson, Tjus, & Gillberg, 1995; Higgins & Boone, 1996; Tjus, Heimann, & Nelson, 2001), learning disabled students (Langone, Shade, Clees, & Day, 1999; Okolo & Ferretti, 1996), and dyslexic learners (Dimitriadi, 2001). In addition, Maki and Maki (2002) directly attributed improved learning to multimedia comprehension in online courses.

Multimedia instruction has been specifically noted to be effective especially for learning abstract subjects such as math (Apostol, 1991; Apostol & Blinn, 1993; Blanchard & Stock, 1999; Clark & Paivio, 1991; Paivio, 1971, 1986, 1991; Szabo & Poohkay, 1996; Tooke, 2001; Wiest, 2001) since teaching with multiple representations facilitates and strengthens the learning process by providing several sources of information (Grouws, 1992; Kozma, Russell, Jones, Marx, & Davis, 1996; NCTM, 1989). Multimedia technologies also have great potential as learning

activities in the primary school context (Baxter & Preece, 1999; Eskicioglu & Kopec, 2003; Jones, 1994; Nulden & Ward, 2002; Smith, 1999). According to Jones (1994), commercial multimedia software titles for children usually lack directed learning objectives. Research examining the impact of computer-controlled multimedia on student learning in school subjects is relatively recent, beginning around 1994. Jones encouraged researchers to focus on exploration of multiple simultaneous representations in school math. Now, 10 years later, there has been progress in this field. Based on recent literature, there are three basic types of projects investigating the impacts of multimedia in K-12 math instruction and learning.

The first type of project includes projects involving the use of multimedia resources to train preservice math teachers at the university level (e. g., Bitter, 1994; Bitter & Hatfield, 1994; Bitter & Pryor, 1996; Daniel, 1996; Dugdale, 2001; Garcia, 1999; Herrington, Herrington, Sparrow, & Oliver, 1998; Herrington & Oliver, 1999; Kim, Sharp, & Thompson, 1998; Lampert & Ball, 1998; Townsend & Townsend, 1992). Lampert and Ball (1998) used hypermedia to enable students to access teacher education materials in two classrooms videotaped over a one-year period. That is, the preservice teachers were video-taped while they were being trained on math instruction. Barron and Goldman (1996) focused on a major strand of math curriculum and used cases for preservice teachers to investigate and discuss. Herrington, Herrington, Sparrow, and Oliver (1998) designed an interactive multimedia resource to develop preservice teachers' knowledge and practices for teaching and assessing mathematics in K-12 classrooms. Herrington and Oliver (1999) described a qualitative study on students' use of higher-order thinking as they use an interactive multimedia program based on a situated learning framework. Sharp and Kim (2000) studied six hours of multimedia-enhanced instruction over a two-week period for preservice elementary teachers in a methods course that emphasized constructivism and involved problem-solving multimedia. Their study found that multimedia-enhanced instruction facilitates students' teaching abilities and confidence in their future teaching. Bowers and Doerr (2003) designed and investigated a multimedia case study for preservice mathematics teachers in methods classrooms. They found that the multimedia case approach received the highest ratings from students enrolled in courses where the case exploration activities were integrally woven into the course goals. Overall, most of these projects promoted students' learning of math teaching methods and their teaching in other fields by integrating multimedia to situate the materials in real contexts.

The second type of study includes students' authoring and/or creation of specific multimedia projects. In the multimedia project conducted by Penuel, Golan, Means, and Korbak (2000), teams of K-12 teachers were trained to develop curriculum-based multimedia projects with students. Results indicated that students in the multimedia project classrooms consistently outscored their peers in the non-project classrooms in various areas such as understanding content, applying principles of designs, and adapting to meet students' needs. Maor (2001) studied 10th grade students to conduct a formative evaluation of an authentic data-based multimedia program. The students' formative evaluation resulted in helpful information for modifying and improving the existing multimedia program, as well as raising further questions regarding how to promote students' development of desired high-level thinking skills in the program. McFarlane, Williams, and Bonnett (2000) involved elementary students in a multimedia authoring project related to drug education using HyperStudio software. Neither the teachers nor the students had previous multimedia experiences, although they were provided with training. At the end of the study, various measures were used to assess students' understanding of the content. The study indicates that student-produced multimedia projects can reveal important aspects of learning that traditional tests may not recognize, such as higher order thinking skills and processes. However, most of these studies were conducted either with middle school students (e. g., Liu & Hsiao, 2002; Macnab & Fitzsimmons, 1999; Wilder & Schoech, 2002) or high school students (e. g., Koroghlanian & Klein, 2004; Looi & Ang, 2000).

The third type of project includes designing and delivering some kind of multimedia instructional materials and then assessing their impact on students' learning. The Cognition and Technology Group at Vanderbilt (1996a, 1996b) developed a well-known series of films called the Jasper Series. The series utilizes hypertext terminology in order to describe their theory that their films offer semantically rich anchors which construct a macrocontext. These macrocontexts present meaningful authentic problems that must be solved. Smith and Westhoff (1992) describe the Taliesin Project that extends far beyond a simple program and speaks to the institutional context as well, including (1) curriculum revision with the aim of overcoming the segmentation of subjects and introducing interdisciplinary block teaching that covers math, science, and technology, (2) development of a hypermedia system with protocolling, communication, network connection, and application, and (3) development of tools for designing lessons. Johnson and O'Neill-Jones' (1999) collaborative team designed a multimedia title called "Wyzt's Playground" to emulate and simulate the real life scenario of building a playground for 4th grade students to practice as a part of math curriculum. Results from this study indicate that the playground project supports the instruction of math and proficiency measures in five NCTM (1989) standards: spatial, patterns, computation, statistics, and communication.

Macaulay (2003) conducted an experiment to study the impact of multimedia on math learning performance of non-English-speaking third world children. In the study, 36 elementary students were randomly assigned into two groups: multimedia (experimental) and non-multimedia (control). All 36 students completed a pretest before the experiment and no statistically significant differences were found between experimental and control groups. Two types of computer-based learning applications on the same type of computers were used to present addition and subtraction concepts in elementary math. The control group was presented the materials using text only while the experimental group used a combination of text, images, animation, and sound. The presentation of math materials in both groups was similar in terms of structure and interactivity. The only difference between the two groups was the inclusion of multimedia components in the experimental group. Results from the posttest indicated that the multimedia group significantly outperformed the non-multimedia group in terms of the mean math test scores.

Moreno (2002) conducted a study on who learns best in elementary math with multiple representations based on an interactive multimedia game in emigrant, low-income, Spanish-speaking children. According to this study, presenting symbolically and visually how an arithmetic procedure works in math does not ensure that all students will understand the explanations unless cognitive theory of multimedia learning is applied to the design. Thus this project suggests focusing on integrating multimedia into the math curriculum design by applying the seven principles from cognitive theory of multimedia learning described previously.

Currently, computer-based instruction containing multimedia appears to be increasingly used as a supplement to traditional classroom instruction. However, systematic research investigating the impacts of multimedia-based learning in math is still largely lacking (Christian, 2003; Fan & Orey, 2001; Herrington, Herrington, & Sparrow, 2000; Koroghlanian & Klein, 2004; Royce, 2002). In order to stimulate more research in this field, an international cooperative workshop entitled “Multimedia Tools for Communicating Mathematics (MTCM)” was held in Portugal in 2000. The meeting aimed at providing, “fruitful and stimulating ground for the further development of multimedia tools for mathematical education, communication, and research,” (Borwein, Morales, Polthier, & Rodrigues, 2002, p. vi). Thus this project is designed to meet the aim of the international meeting as well as to meet other multimedia design challenges in math proposed by other researchers in the field (e. g, Astleitner & Wiesner, 2004; Cognition and Technology Group at Vanderbilt, 1996b).

Based on the above review, it is found that the multimedia curriculum and instruction are neither a cure-all for problems facing the schools nor are they fads without impact on student learning. When designed and used properly, multimedia curriculum and instruction may serve as important tools for improving student proficiency in math and the overall learning environment of the school. This is consistent with Wenglinsky’s (1998) conclusion regarding the impact of computers on student learning. In addition, a careful review indicates that those limited studies in the literature are not systematic or rigorous for various reasons: (a) most multimedia designs did not systematically follow the principles based on cognitive science and proposed by Mayer (2001); (b) most research designs in elementary math were not well controlled; (c) most studies did not examine the variable of attention; (d) some studies that were highly controlled have problems generalizing to real educational classrooms; (e) none of those studies assessed the long-term effects of multimedia instruction on students’ standardized tests; and (f) no studies covered one or more years of elementary math curriculum. Thus this study is necessary to address all of the described previously challenges.

3. Provide the Significance Of the Project

Although many math teachers also use overheads in their teaching, the effects on student learning are still very limited. The most significant change in the classroom today is not just the addition of computers, but direct Internet access (Cattagni & Farris, 2001; Education Week, 2001; Williams, 2000). However, education has not progressed beyond the machines. For most students in K-12, the lecture/textbook/workbook approach is the primary medium for the delivery of math instruction. Unfortunately, textbooks are often presumptuous about the breadth and depth of students’ background knowledge, are written at readability levels that exceed those of average students and fail to structure information to facilitate comprehension of important concepts and relationships. As a result, students from low-income backgrounds are often excluded from receiving the benefits of effective math instruction (Chambel & Guimaraes, 2002).

This project is designed to investigate the effects of multimedia research on learning and long-term retention in elementary math. Based on (a) the NCTM directives, (b) Mayer’s (2001) cognitive theory of multimedia learning, and (c) multimedia literature presented in the previous section, it is hypothesized that the multimedia math curriculum will have significant positive impacts on students’ cognitive processes and learning in math. That is, there will be significant mean differences between the experimental group (that will receive the multimedia math curriculum and instruction) and the control group (that will receive regular math curriculum and instruction) for low-income third graders in terms of these dependent variables: (a) attention to math instruction, (b)

immediate recall of the newly acquired math information, (c) long-term retention of the newly acquired math information, and (d) academic standardized test scores in third grade as measured by the math portions of the standardized achievement tests.

The focus of this project is not on a replacement for math teachers, but using the computer-based multimedia curriculum and instruction to assist teachers and students in the math learning process. The actual intervention in this project is multimedia curriculum and instruction in elementary math. Multimedia-based curriculum and instruction can be an effective alternative to the exclusive dependence on textbook-based math instruction. In this project, multimedia refers to the integration of different media such as text, graphics, animation, sound, video (digital or analog), imaging, and spatial modeling into a computer system where appropriate (Jonasses, 2000). Multimedia representations including animation typically provide a rich set of communication vehicles and have been essential for communicating and transmitting mathematical concepts to learners (Chambel & Guimaraes, 2002).

This project aims to foster meaningful learning by integrating multimedia design principles into the elementary math curriculum in grades 3-5. This project will examine how to design, develop, and deliver the effective multimedia curriculum and instruction by integrating multimedia design principles in elementary math curriculum materials for grades 3-5 in local elementary schools for three years. The planned curriculum materials, when fully designed and developed, will form an instructional sequence that covers the math curricula for grades 3-5. This project has three major tasks: (a) to design and develop effective multimedia curriculum and instruction for math based on recent cognitive research in multimedia and cognition as described previously, (b) to deliver the effectively designed multimedia curriculum and instruction for math, and (c) to empirically examine the effects of the above multimedia curriculum and instruction on students' learning, cognitive processes, and academic achievement for low-income and low-achieving children.

This project will advance solutions to underachievement in elementary math that teachers confirm to be a critical problem from their point of view. According to Eskicioglu and Kopec (2003), computer-based multimedia should be employed as the centerpiece for an emerging pattern of instruction. We agree with this perspective based on our recent teaching and research experiences. We have found that computer-based multimedia can promote independent and cooperative learning, and improve performance of low achievers and special student populations. The overarching purpose of this project is to bridge the gap among the laboratory research in cognitive science, multimedia learning, and the practices of in-service teachers. This knowledge could then be used to improve elementary math instruction.

This project is significant in both practice and theory for many reasons. In practice, different from previous multimedia research projects, this project focuses on (a) one fundamental school subject--math, (b) the design and development of computer-based multimedia curriculum and instruction by integrating Mayer's seven multimedia design principles mentioned previously, (c) numerous variables of students' cognitive functioning such as attention, recall, and long-term retention, and (d) students' academic achievement as measured by standardized tests. This project will also theoretically contribute greatly to the multimedia literature in K-12 math curricula and education.

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Improving Learner Performance through Olfactory Intervention

Aaron Loewer

Abstract

Sensory inputs in educational environments can influence learner performance. Specifically, the sense of smell (olfaction), with its neurological connections to emotion can be utilized to enhance learner performance and reduce learner anxiety. The purpose of this paper is to review aroma-based learning research in order to answer the following research questions: Can a pleasant ambient aroma enhance learner performance when released in an instructional environment? What is the influence that a pleasant aroma might have on learner anxiety? The results in most of the studies reviewed backed the use of pleasant aromas in learning environments. Two possible explanations are that some pleasant aromas have been shown to enhance connections between the learner and subject matter, while they also contribute to reductions in human anxiety.

Introduction

Olfaction, or the sense of smell, is a powerful, emotionally tied capability (Herz & Engen, 1996). This paper demonstrates that humans can learn to use olfaction to enhance performance in diverse environments and situations. Various behaviors or tasks exist in which dealing with olfactory information is a key element. For example, a car driver who perceives the odor of an overworked engine is presented with olfactory cues to change driving behavior, such as shifting to a higher gear, or to provide maintenance to the car by checking levels of radiator fluid or oil. The smell of worn out brake pads can also prompt behavioral or maintenance choices like shifting to a lower gear so the engine can slow the car's momentum, or checking the thickness of the brake pads to see if repairs are needed.

Food preparation is another area of activity that provides multiple instances where olfaction can aid performance. When selecting foods, chefs can use their olfactory sensitivity to perceive the ripeness of fruits such as pineapple and cantaloupe, or the freshness of milk or eggs. While baking or cooking, olfactory hints inform the cook as to whether or not an item has been cooked long enough, or too long. Prior to serving food, chefs use their sense of smell to evaluate food odor and taste as "perception of odors and flavors [has] similar neural bases" (Phillips & Heining, 2002, p. 204). Hence, the plugging of one's nose can be an effective approach when taking in foods or medications that taste unpleasant.

In a few cases, human behavior is unconsciously influenced by olfaction. One well-documented example is mate selection. Thornhill and Gangestad (1999) demonstrate that females not taking birth control pills are able, through olfaction, to detect males who will provide genes that will generate the healthiest possible posterity (p. 191). While males do not possess this ability, they do however possess the ability (along with females) to judge expected body scent attractiveness based on portrait attractiveness (1999).

The influence that pleasant aromas can have on learner performance has been tested in numerous studies (Aggleton & Waskett, 1999; Baron, 1990; Baron & Kalsher, 1998; Cann & Ross, 1989; Deethardt, 2003; Diego, Jones, Field, Hernandez-Reif, Schanberg, Kuhn, McAdam, R. Galamaga & M. Galamaga, 1998; Ehrilichman & Halpern, 1988; Epple & Herz, 1999; Herz, 1997; Ludvigson & Rottman, 1989; Nagai, Wada, Usui, Tanaka & Hasebe, 2000; Smith, Standing & de Man, 1992). However, little is known in the instructional technology field about such findings. Consequently, some instructional technologists may be limiting themselves to designing and redesigning performance interventions without considering an important element of instruction—the use of olfactory abilities in triggering conscious and subconscious cues.

The research questions for this review are two basic questions that instructional technologists need to know in order to effectively incorporate olfactory stimulation into their designs: Can a pleasant ambient aroma enhance learner performance when released in an instructional environment? What is the influence that a pleasant aroma might have on learner anxiety? The first question is important because designers need to know whether or not olfactory intervention even works, and whether or not it has been proven to work in various settings. The second question is based on the importance of emotions in olfactory research. As will be explained further, olfactory connections with the limbic system indicate that interventions involving pleasant aromas may reduce anxiety as experienced by learners.

Theoretical Basis

Four principles explain the theoretical importance of reviewing studies that examine the influence of olfaction on learner performance and anxiety. Anxiety is defined by Merriam-Webster (2006) as an "abnormal and overwhelming sense of apprehension and fear often marked by physiological signs (as sweating, tension, and increased pulse), by doubt concerning the reality and nature of the threat, and by self-doubt about one's capacity to cope." The four theoretical principles are discussed in the following order: environment, context, inputs, and affordances.

According to Blanchard and Thacker (2006), the environment is one of the key factors determining human performance. Their model claims that performance is the product of three factors: (a) motivation, (b) KSA (knowledge, skills, and attitudes), and (c) environment. They explain "it is the combination of these factors that determines the person's performance. The likelihood of engaging in any activity, then, is limited by the weakest factor (….) If the environment does not support the activity or blocks it, then it doesn't matter how motivated or knowledgeable you are – you won't do it" (p. 76). Granted, Blanchard and Thacker (2006) are speaking of more than just the sensory inputs in the environment, such as organizational structure and culture, but they are also clear regarding the importance of the surroundings in which performance is taking place.

Environmental contexts that are increasingly similar during acquisition, retention and retrieval (Anderson, 1995) can enhance performance during these neural activities. On the other hand, lack of contextual cues could lead to a decrement in performance. Driscoll (2000) states "When context changes from learning to application or practice, learners often fail to transfer the knowledge they acquired in one context to the other, related context" (Driscoll, 2000, p. 154). Furthermore, she states that "context plays an important role in learning. In familiar contexts, learners can relate new information and skills more easily to what they already know than if the learning context is unfamiliar" (p. 154).

The problem of transfer can sometimes exist when learning environments or contexts are dissimilar from those in which recall takes place. High-end simulations can be employed to reduce contextual gaps, but for simulations to truly reflect all aspects of a learning/performance environment, all sensory inputs should be considered. Gibbons and Fairweather (1998) emphasize that when representing information "the designer must be aware of the alternatives for communicating through all of the sensory channels: graphic and motion graphic, tabular, verbal and non-verbal auditory, tactile, kinesthetic, and olfactory" (p. 318). Making the point clear, Engel (2000) emphatically titles her book, *Context Is Everything*.

The importance of communicating and representing information leads to the cognitivist concepts of "inputs" and "means" as discussed by Driscoll (2000). "The results of learning are to be explained through inputs (largely external to the learner) and means (largely internal to the learner)" (p. 156). Regarding inputs that are external to the learner, Gibson's (1966) ecological perception theory introduces the concept of affordances. "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1986, p. 127). In other words, "affordances are an object's properties for which it can be used in a particular moment – they are an object's invitations. For instance, a door handle possesses the initial affordance of grasping and, secondarily, turning" (Loewer, 2006, p. 24). Gibson (1986) summarizes:

> The perceiving of these mutual affordances is enormously complex (. . .) is based on the pickup of the information in touch, sound, odor, taste, and ambient light. It is just as much based on the stimulus information as is the simpler perception of the support that is offered by the ground under one's feet. For other animals and other persons can only give off information about themselves insofar as they are tangible, audible, odorous, tastable, or visible. (p. 135)

In summary, various theorists and practitioners emphasize the importance of four theoretical principles: environment (Blanchard & Thacker, 2000), context (Driscoll, 2000; Engel, 2000; Gibbons & Fairweather, 1998), inputs (Driscoll, 2000), and affordances (Gibson, 1966; 1986). While not necessarily mentioned in the studies examined in this review, each principle contributes to the theoretical basis for examining olfaction-based learning studies. Designers and developers who consider these principles during the ISD process may find grounds to produce instruction that incorporates olfactory cues along with inputs to other sensory modalities.

Literature Review

This review consists, first, of summaries of two previous reviews of olfactory research. Afterward, the review of individual studies that pertain to the research questions is presented. Two integrative reviews were located in which the relationship between cognition and olfaction was examined, these are Richardson and Zucco (1989)

and Herz and Engen (1996). Unfortunately, both pairs of reviewers failed to present their findings in a concisely summarized manner.

Richardson and Zucco (1989) reviewed previous research on the following topics: Subjective description of odors, odor detection, odor identification, memory for odors, and brain damage leading to loss of olfactory ability. The reviewers did not include studies that examine the influence of olfaction on variables pertinent to this review such as anxiety, mood, associated memories and learner performance. Like many studies in olfaction, Richardson and Zucco (1989) focused primarily on the human abilities (or disabilities) of remembering, describing and categorizing odors.

Herz and Engen (1996) reviewed previous research on the following topics: (a) memory for odors (including long and short-term odor memory), (b) verbal abilities to describe odors, (c) olfactory imagery, (d) distinctiveness of odor memory, and (e) memories evoked by odors that are autobiographical or context-dependent.

Their review lends itself much more to the topic of this paper, in particular, summaries of research conducted on human memories evoked by odors. They summarized “the first direct examination of odor-evoked memory” (p. 306), as found in Herz and Cupchik (1995) where the researchers “used a paired-associated incidental learning paradigm to examine whether odors evoked more emotional memories than verbal cues” (Herz & Engen, 1996, p. 306). They found that the odor and verbal cues were equal in their ability to elicit correct responses but that the odor cues had a “higher emotional intensity” (p. 306).

Regarding context-dependent memory, Herz and Engen (1996) pointed to four studies in which an ambient odor is present during study and testing. These studies are Cann and Ross (1989); Herz (1997b); Schab (1990); Smith, et al., (1992). Herz and Engen (1996) also explained the cause of powerful emotions that are generated by olfactory experiences:

> The primary olfactory cortex forms a direct anatomical link with the amygdala-hyppocampal complex of the limbic system. Only two synapses separate the olfactory nerve from the amygdala, which is critical for the expression and experience of emotion (Aggleton & Mishkin, 1986) and human emotional memory (Cahill, Babinski, Markowitsch & McGaugh, 1995). Only three synapses separate the olfactory nerve from the hippocampus, involved in the selection and transmission of information in working memory, short- and long-term memory transfer, and various declarative memory functions (Eichenbaum, in press; Schwerdtfeger, Buhl & Gemroth, 1990; Staubli, Ivy & Lynch, 1984, 1986). No other sensory system makes this kind of direct and intense contact with the neural substrates of emotion and memory, which may explain why odor-evoked memories are unusually emotionally potent. (p. 300)

Additional literature examined for this review included books, journal articles, web sites and personal vitae of researchers. Search terms included various combinations of the following: affect, anxiety, aroma, biofeedback, blood pressure, cognition, fragrance, heart rate, knowledge, learning, memory, nasal, nose, odor, olfaction, performance, perception, scent, sense, and smell.

Databases for locating sources were accessed primarily through the library at Utah State University. They included: Digital Dissertations, Education Full Text, ERIC via EBSCO Host, ERIC via the US Department of Education, PsychINFO via EBSCO Host, and Biological Sciences. An associate accessed numerous full-text articles at the Jean and Alexander Heard Library at Vanderbilt University and sent them to the researcher.

Inclusion Criteria

The following were established as inclusion criteria for this review: Research must be conducted on recall of memories and/or learned content and skills, as opposed to research on recall of odor names, or odors themselves. This criterion alone caused the exclusion of the majority of articles cited in the aforementioned Richardson and Zucco (1989) review. Additional criteria included researcher documentation of: random assignment to treatment and control groups, odors used in treatment groups, odor release methods, sample size, and age of subjects.

Originally, the researcher required documentation of effect size, but Herz (1997a) was the only researcher to include such findings, thus the criterion was adjusted. Although attempts were made to calculate effect sizes from results of other studies, the reported data was generally insufficient. Gathering other data was also unsuccessful. For instance, R.A. Baron was asked to provide data for items such as male to female participant ratios in Baron (1997), but he had “disposed of the data for that study a long, long time ago” (R.A. Baron, personal communication*,* December 6, 2005).

The results in most of the studies reviewed backed the use of pleasant aromas in learning environments. Two possible explanations are that some pleasant aromas have been shown to enhance connections between the learner and subject matter, while they also contribute to reductions in human anxiety.

Sample

Twenty-five articles were identified for inclusion in the review, many of which contained multiple studies. The studies were categorized according to the order of the research questions: (a) olfactory studies on learner performance, and (b) olfactory studies on learner anxiety. It should be noted that some of studies examined both performance and anxiety, thus, they were included in both categories.

Olfaction and Learner Performance

Olfactory studies on learner performance show that pleasant aromas such as peppermint, rosemary and lavender can be used to enhance connections between learning and testing. For example, Schab (1990) found that memory retrieval during a test can be aided if the same aroma is present in both the encoding and testing conditions. He also showed that learner performance can be further enhanced when the aroma is related, or congruent with the task at hand. For example, if a female student is learning about the biology of apples, her ability to recall specific content might improve if an apple scent is present during both encoding and retrieval.

Similarly, Aggleton and Waskett (1999) found that congruent aromas distributed in a Viking museum enhanced participants' ability to perform delayed recall of Viking-related content. They remembered "the types of clothing and jewelry worn by the Vikings, the types of foods eaten, the nature of the buildings and the classes of items sold in Viking York" (p. 3).

Baron and Kalsher's (1998) examination of the effects of a lemon fragrance on simulated driving performance is another example. Subjects were divided into four groups in which two treatments were administered—a lemon scent, or a gift, to randomly assigned groups. The researchers found that performance was best achieved in the scent condition in which no gift was received.

Eighteen studies (mean sample size 58.7) that examined the effects of pleasant aromas on performance were included in this section of the review. They are: Aggleton and Waskett (1999); Baron and Kalsher (1998, Study 1); Baron (1990); Cann and Ross (1989); Deethardt (2003); Diego, et al., (1998); Ehrilichman and Halpern (1988); Epple and Herz (1999); Herz (1997a, Study 1); Herz (1997a, Study 2); Herz (1997b, Study 1); Herz (1997b, Study 2); Ludvigson and Rottman (1989); Nagai et al., (2000); Schab (1990, Study 1); Schab (1990, Study 2); Schab (1990, Study 3); Smith, et al., (1992).

Twenty-one tasks were completed by participants in the 18 studies (Figure 1). The frequencies of these tasks were: Cognitive (8), Word recall (6), All others (4), Procedural (3). The most common aromas used in the performance studies (listed alphabetically) were almond, apple, chocolate, cinnamon, jasmine, lavender, lemon, peppermint, pine, and rosemary.

In the 18 studies listed above, all findings were statistically significant in favor of using pleasant aromas in performance situations except two: Deethardt (2003), and Ludvigson and Rottman (1989). The Deethardt (2003) study examined participants' ability to recall paired word associates where words were matched with specific aromas from seven combinations of dry teas, spices and incense. Ludvigson and Rottman (1989) had participants complete analogies, math problems, and vocabulary recall while being exposed to aromas of cloves and lavender.

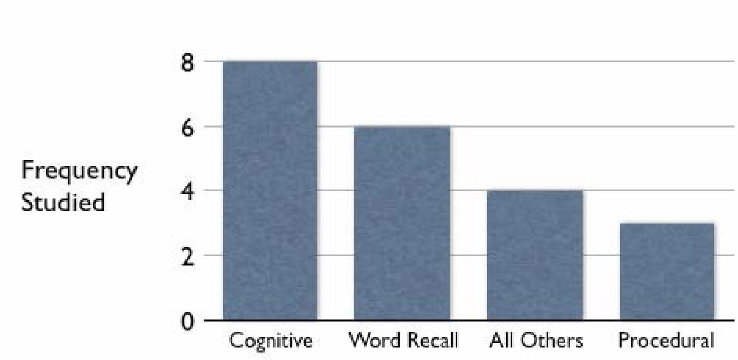

Figure 1. Types of tasks completed by participants in performance studies.

Unfortunately, only two studies (by the same researcher) included a report of effect size, both of which used violet leaf in the scent condition. Herz (1997a, Study 1) reported an effect size of .11 when participants completed word recall tasks while experiencing public speaking anxiety. Herz (1997a, Study 2) reported an effect size of .42 when participants completed word recall tasks while experiencing test anxiety. While these effect sizes may not be large, they are effect sizes that show significant, positive results.

The results of olfaction-based performance studies may be explained by Smith, et al., (1992) who cite Tulving's (1983) encoding specificity principle where "verbal memory performance is enhanced when the contextual, or incidental, stimuli present at the time of retrieval are the same as those which were present during the initial learning" (p. 339).

Olfaction and Learner Anxiety

As a result of direct links between olfactory processing and the limbic system (which some researchers claim to be the biological source of human emotional response), odors can strongly influence emotions. Kringelbach (as quoted by Hoelgaard, 2004) states that while other sensory inputs pass through the thalamus, the same "does not happen with olfactory input – that goes straight to the emotional response centre" (¶ 9).

Olfactory studies on learner anxiety (indicated by both self-report and physiological data) show that subjects' moods and attitudes can be influenced by both pleasant and unpleasant fragrances. For instance, Baron (1997) and assistants approached passersby in a shopping mall in areas where half of the passersby were in the presence of pleasant aromas (coffee shops, bakeries). The passersby were asked to complete a favor, either to provide change or the time of day for one of the assistants. Findings indicated "a higher proportion of passersby helped the accomplice when pleasant fragrances were present than when they were absent and that this was true for both" (p. 501) genders. Participants also filled out mood questionnaires (some before, and some after completing the favor). Subjects in the presence of the aromas reported being in a more favorable mood than subjects not exposed to the aromas.

While the majority of olfactory researchers measure anxiety using self-report questionnaires, some also employ physiological assessments. Diego et al., (1998) used both self-report and EEG (electroencephalogram), also known as a brain wave test, to monitor subjects' brain activity when given three minutes of aromatherapy. Two aromas, lavender (which is considered to be relaxing) and rosemary (stimulating) were used in the experiment. Data gathered using EEG showed that the lavender-exposed group experienced increased drowsiness while the rosemary-exposed group experienced increased alertness. These data were also consistent with subjects' self-report of mood. Both groups performed math computations (pre- and post-aromatherapy) and results showed that both groups performed faster after the aromatherapy. Interestingly, the lavender group was more accurate in its math responses than the rosemary group, suggesting that relaxation may assist concentration (p. 223).

Nagai et al., (2000) examined the influence of participant-selected aromas (and their documented intensities) during a psychomotor task. They used a blood pressure monitor and a polygraph system which monitored "respiratory movement, electrocardiogram, pulse wave of the left middle finger, and skin temperatures of the forehead and the left forefinger" (p. 228). Results indicated that during a rhythmic handgrip exercise, diastolic blood pressure was significantly lower for the odor group than the non-odor group.

Twelve studies (mean sample size, 93.1) were included in this section of the review. As mentioned earlier, some overlap existed between the performance studies and anxiety studies, thus some experiments were included twice. They are: Baron (1990); Baron (1997); Baron and Kalsher (1998, Study 2); Baron and Thomley (1994); Diego et al., (1998); Herz (1997a, Study 1); Herz (1997a, Study 2); Herz (2004); Lehrner, Eckersberger, Walla, Pötsch and Deecke (2000); Ludvigson and Rottman (1989); Sanders, Diego, Fernandez, Field, Hernandez-Reif and Roca (2002, Study 1); and Spangenberg, Crowley and Henderson (1996).

Eighteen variables were examined in the 12 studies. Results in 13 of the 18 variables examined confirmed that pleasant aromas could reduce human anxiety. The non-significant affects came as a result of two aromas investigated: Lemon (1) and Violet leaf (4). Interestingly, a lemon scent was used in Baron and Kalsher's (1998, Study 1) simulated driving performance study, finding lemon to significantly enhance performance yet in Study 2, the lemon aroma did not positively influence participant affect.

From the total number of affects reported, the frequencies at which specific types of affect were examined included the following: affective state after study (3), mood (3), emotional arousal (2), pleasure (2), relaxation (2), state anxiety (2), depression (1), emotionality of odor-evoked memories (1), affective evaluations of a store's appeal (1), and trait anxiety (1). The most common aromas used in the twelve studies (listed alphabetically) were lavender, lemon, orange/orange citrus, rosemary and violet leaf.

Amidst ongoing research, little is known of the affective domain. Martin and Reigeluth (1999) state that they “believe there are compelling reasons for including affective development in all types of learning environments” (p. 507). Goleman (1994) summarizes possible reasons for the importance of affective research and instruction.

> [The] architecture of the brain gives the amygdala a privileged position as an emotional sentinel, able to hijack the brain. [Sensory] signals from the eye or ear travel first in the brain to the thalamus, and then – across a single synapse – to the amygdala; a second signal from the thalamus is routed to the neocortex – the thinking brain. This branching allows the amygdala to begin to respond before the neocortex, which mulls information through several levels of brain circuits before it fully perceives and finally initiates its more finely tailored response. (p. 17)

One group that is exemplary in affective examination is the Affective Computing Group (http://affect.media.mit.edu/) at Massachusetts Institute of Technology, which describes its work in the following way:

> Our research develops new technologies and theories that advance basic understanding of affect and its role in human experience. We aim to restore a proper balance between emotion and cognition in the design of technologies for addressing human needs. (¶ 1)

One of their current projects challenges learners to “focus on a topic such as math in the presence of strong emotions (problems at home, or feelings for the teen across the room)” (http://affect.media.mit.edu/projects.php, ¶ 6). The objective is to teach students how to apply meta-affective skills for handling emotionally heightened situations.

Another branch of affect research promotes physiological data gathering in order to assess emotional conditions of learners. Moss (2003) asserts that heart rate, respiration, muscle tension and hand temperature are manifestations of anxiety, all of which can be physiologically gathered. As mentioned previously, some of the studies reviewed in this paper documented the use of physiological anxiety assessment (Diego et al., 1998; Nagai et al., 2000; Sanders et al., 2002). Peek (2003) explains that in gathering physiological data, instrumentation is used to “(a) monitor a physiological process of interest, (b) measure (objectify) what is monitored, and (c) present what is monitored or measured as meaningful information” (p. 45). As such, increasingly accurate information can be gathered from research participants, whereas self-report mechanisms may be unreliable, or the actual reporting by the participant may be biased.

Conclusion

One of the purposes of this conference is to strengthen connections between new technologies and educational goals. Where the goal of educators in most sectors is to create learning experiences that enhance learner performance, new technologies employed to achieve such a goal may be found in the domain of physiological assessment. If one of the first objectives of a designer is to understand the audience then physiological data can provide valuable details about learners, their possible levels of anxiety, and their experiences in various instructional environments.

The concepts of environment, context, inputs, and affordances, as previously discussed, demonstrate the importance of strengthening connections between acquisition, retention and retrieval (Anderson, 1995) through olfactory intervention. Incorporating olfactory interventions into the “selection, sequencing and posing of problems” (Foshay & Gibbons, 2003, p. 22) may augment an instructor’s ability to foster contextual connections in learners.

A sample of the growing body of olfactory research literature has been presented in this review. Specifically, literature has been evaluated regarding the influence of olfaction on learner performance and anxiety. Twenty-five articles, some of which contained multiple studies, were located and included in the sample. Overall, many studies point out the fact that not only do olfactory stimuli serve as adequate cues for recall, they also serve as potent cues for recall of highly emotional memories.

To directly answer the research questions, the majority of the studies reviewed show that pleasant aromas can enhance learner performance. Additionally, many of the studies reviewed have also shown pleasant aromas may decrease human anxiety. The level of influence that aromas had on anxiety was not examined, but it is reasonably safe to conclude that various pleasant-smelling aromas may assist learners with relaxation during encoding and recall. Without such assistance, these experiences may remain cognitively, or affectively uncomfortable to learners. While this review focuses primarily on olfaction as an emotionally-tied human sense (Herz & Engen, 1996), there is much that the field might also gain through additional research that shows how olfactory stimulation might be combined with other sensory stimulation to improve performance and decrease anxiety.

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Voices of Children: Critically Exploring Visual and Verbal Literacies through Photography

Dr Pauline Lysaght
Ms Roslyn Westbrook
Assoc. Prof. Ian Brown
University of Wollongong

Prof. Rhonda Robinson
Northern Illinois University

Abstract

Voices of Children is an innovative research project that explores the notion of multi-literacies through images and text produced by children from around the world. In the initial phase of the project, children from five different countries (Australia, Hong Kong, Malaysia, Thailand and the U.S.A.) have constructed photographic images and written responses that document their everyday experiences. The images and text are powerful mediums for communicating the personal and cultural dimensions of the children's lives and, as such, provide a basis for analysis that draws on a range of different approaches. This paper provides a discussion of the framework for the analysis as well as presenting some important themes that examinations of the images and text have revealed.

Overview of the Project

> *A photograph is both a pseudo-presence and a token of absence. Like a wood fire in a room, photographs—especially those of people, distant landscapes and faraway cities, of the vanished past—are incitements to reverie* (Sontag, 1977, p.16).

This paper reports on the findings of *Voices of Children*, an international research project that provides an opportunity for exploring meaning through photographic images and text constructed by children from across the world. This project was initiated by researchers from the Faculty of Education at the University of Wollongong (UOW) in Australia and was awarded funding through an international grant aimed at strengthening partnerships with institutions overseas. The initial phase included colleagues in four other institutions: Hong Kong City University, Universiti Sains Malaysia, Assumption University in Thailand and the University of Northern Illinois, U.S.A. Generous funding from Adobe Systems, U.S. later supplemented the original funds which, more recently, has supported the involvement of a number of other countries including Samoa, Guatemala, Zambia, Qatar as well as indigenous Australian communities located in remote areas.

So far, over one hundred and fifty children have been provided with disposable cameras that allow them to take photographs of what they see on a daily basis. At the same time, they have been given booklets that encourage them to write about themselves, their families and the world in which they live. The images and text produced by the children are regarded as artefacts that reflect important personal, cultural and social dimensions. They complement one another and provide the viewer with opportunities for exploring common elements as well as diverse experiences in the lives of children across the world. The project also involves a travelling photographic exhibition that draws on the images and text as artworks generated by the children. Exhibitions in each of the countries involved in the project provide a platform for participants as well as a wider audience to examine the artworks as representations of individual and cultural narratives. An additional feature of the project is the development of a website that will give participants and others an opportunity to view the images. The website which can be found at www.voicesofchildren.org contains all of the images grouped according to the location from which they were drawn.

The project encourages children and adults alike to make sense of the conditions that define their daily lives, as well as the lives of others. Its focus embodies a number of related perspectives: social justice, educational and pedagogical. From a social justice perspective, those who take part in the project are provided with opportunities

for engaging with the experiences of others and for empathising with them, a vital process where self-awareness and social change are goals. As Frank (2000) observes, “taking the other’s perspective is a necessary step in constructive social change” (p. 94, cited in Denzin & Lincoln, 2005, p. 668). Educationally, the project provides opportunities for children to make meaning of their real world experiences through mediums that encourage critical engagement in learning (McGirr, 2001). It supports children from different cultures in developing the skills they require for communicating, understanding, translating and critically examining their different worlds. Learning that develops multi-literacies requires strategies that provide for these deeper levels of meaning. Finally, from a pedagogical standpoint, educators must develop strategies for teaching and learning that support their students in developing a critical understanding of their world. Roslyn Arnold (2006) acknowledges the imperative of teachers to blend student experience and interests with the knowledge and skills inherent in effective learning, whilst responding to changing societal expectations and needs. Through the promise it offers of engaging students whose experiences are both similar and yet diverse, *Voices of Children* provides a useful basis for developing pedagogies that have relevance for this century.

Introduction

From an educational perspective, it is important to provide a multi-modal approach to teaching and learning, so that students are given opportunities for learning in a variety of modes and through a range of technologies (Unsworth, 2001). Educational interventions that focus on the development of multi-literacies support the ability of students to access and make meaning across a range of learning environments. In its efforts to keep pace with the rapid change that permeates the modern world, education has broadened its base and the simple concept of literacy has diversified to meet the demands made by changing curricula. Participation in this new learning environment requires skills that have not necessarily been provided by traditional educational practices and, where access to them may have been available, the skills required have not always been adequately developed (Brown & Bamford, 2004). Opportunities to explore meaning through images and text reflecting authentic experiences require children to develop a broader range of skills than has previously been the case.

The combination of image and text as complementary dimensions within a framework for analysis are a unique feature of *Voices of Children*. Images often reveal experiences that do not translate into the written word, whilst that which is not readily visible may be revealed in writing. In both cases, image and text are the result of what Muffoletto (2001, p.2) refers to as “ideologically formed intentional acts” that enable viewers to construct their own meanings. They provide opportunities for exploring personal, cultural and social experiences. In this project, the focus on visual literacy refers to the ability to make meaning from images, whilst the written responses provided by children clearly encourage an ability to engage with the written word (“literacy” in its most traditional sense). According to Kress and Van Leeuwen (1996), students need to think critically about visual data and develop the ability to understand layers of meaning. This viewpoint is equally as important for the written word. Importantly, for researchers, educators and students, the combination of detailed information provided through both avenues makes it possible to examine the personal lives of children as well as raising their voices, individually and collectively (Hauser, Brown & Prosser, 1997). Whilst globalisation has effected a blurring of the boundaries that define us (Weisner & Lowe, 2005), *Voices of Children* provides a valuable opportunity for preserving and valuing distinct identities as they exist across a variety of contexts.

The development of skills across multi-literacies is vital for elementary and secondary school students to be able to engage in a meaningful way with the wide range of material with which they are regularly confronted in both formal and informal learning environments (Hubbard & Greh, 1991; Christopherson, 1997; Roblyer, 1998; Roblyer & Bennett, 2001; Brown & Bamford, 2004). The development of this knowledge demands the creation of a new language, a wider range of strategies and a diverse range of materials that will encourage students to make meaning through inter-modal interactions (Unsworth, 2001). Traditional educational practices and the strategies on which they frequently rest often fail to adequately and effectively support the learner in the development of the skills necessary for operating in an environment that is increasingly demanding. In response to this situation, opportunities that allow students to engage in meaningful experiences involving a range of literacies are vital (Muspratt, Luke & Freebody, 1997).

Research Framework

The research underpinning this project seeks to involve children in experiences that will allow them to present their own views of their realities with limited adult direction. Their written responses have been generated by a range of simple statements asking them for information about their families, their experiences and their wishes for change in the world. With regard to the photographs they construct, they have been given the freedom to capture images without adult intervention or censorship. Through this combination of activities, the researchers have sought to provide as much scope for expression as possible. In his discussion of the value of audio-visual records for research in the social sciences, Kellehear (1993) observes that visual and other sources "can be important clues to the cultural world of people whose communication emphasis is not strongly placed on speaking" (p.73-74). In this case, "speaking" can be read as "writing" and, given the constraints involved when younger children as well as young people with limited experience in the English language are required to produce written responses, the value of the visual image is extremely important.

In order to respond to the demands of this research, a number of key questions have been formulated to guide the project:

1. How do young people in a variety of different locations across the world represent their everyday experiences through photographic images and text?
2. What words and phrases do young people use to describe and explain their experiences? What understandings of their experiences can we, as researchers, draw from their words?
3. How do the images they construct reflect their experiences and what are the understandings we can draw from them?
4. How can images and text combine to provide detailed accounts of the lived experiences of young people?
5. What are the understandings that participants as well as audiences develop in response to the presentations of images and text as part of the *Voices of Children* project?
6. How can the information gathered through this project be used to develop pedagogies that will address societal needs and expectations for educating young people from a range of different cultures?

Our responses to these questions rest on a clear analysis of the data gathered through the project as well as a commitment to presenting images and text for audiences in ways that respect the integrity of the material that is produced by the children involved. No clear theoretical framework that encompasses the broad dimensions of this project is available and, instead, a grounded theory approach has been taken in the collection and analysis of data. This involves an iterative process that includes asking questions of the data in order to develop more detailed insights and rests on a reciprocal relationship between data collection, its analysis and theory (Strauss & Corbin, 1990). In terms of analysis of both the images and text, methodologies that are appropriate to each medium have been considered. In both cases, content analysis has acted as a practical means of organising and categorising data, whilst a narrative approach with regard to interpretation has also been useful.

Content analysis is a useful tool for organising and categorising the range of responses that the children have submitted. It provides a means of refining the data down into particular words or elements of the images. This method of analysis supports the identification of categories that include common as well as unusual responses (Silverman, 2001). Categories that are drawn from the data contribute to the identification of patterns across responses and, with the data organised in this manner, it becomes possible to identify emerging themes (Kellehear, 1993). Interpreting the data from a narrative perspective enriches this process, making it possible to develop the themes in a more coherent way (Chase, 2005).

Both images and text may be viewed as vehicles for conveying stories from a narrative perspective. Definitions of narrative vary enormously according to Rimmon-Kenon (2006) and Squire (2004) notes that, at minimum, a written response must contain two clauses in order to be considered narrative. Many of the written responses submitted by the children readily exceed this requirement. With regard to images, Banks (2001) suggests that internal and external narratives should be considered. Internal narratives embody the story that an image communicates to a viewer, whereas external narratives reflect the social context in which the image is embedded. According to Banks (2001), elements of an external narrative, or "information about the nature of the world beyond

the photograph, are always involved in readings of the internal narrative" (p.12). Whether the stories are read through images or text, both contain narrative properties. White (1981, p.20, cited in Rimmon-Kenan, 2006, p.14) suggests that our fascination with the stories of others occurs because, in them, "reality wears the mask of a meaning, the completeness and fullness of which we can only imagine, never experience". Rather than representing transparent windows through which the lives of others can be viewed, narratives provide a means of gaining some insight into the perspective of another, allowing us to develop a taste of the experiences of others, at least in our imaginations.

Reading the Images

As global boundaries become less clearly defined, the image provides the basis for a common language. It is significant that for each of the children, as artists, the locations they occupy personally and culturally determine what they record (Ewald & Lightfoot, 2001). On examination of the images we find that they have been culturally determined through the choice of the artist. According to Fuery and Fuery (2003), "to comprehend this particular capacity and operation of the image, and its high significance in culture, images need to be 'reviewed'—that is, seen outside their normal functioning" (p.90). It is intended that the way in which the images are viewed will challenge and disrupt the perceptions and understandings of the audience. From this perspective, the project allows both the artist and the viewer the ability to describe and identify the way in which culture represents or expresses itself (Fuery & Fuery, 2003).

Deconstructing or "unpacking" the elements of an image for analysis is a complex process. In this project, Collier's (2003) approach has been adopted. This involved a collective overview of each country involved, systematically working within and between the images under review. Collier's (2003) four-stage model, which incorporates the tenets of content analysis, made it possible to uncover a number of categories, patterns and themes and to develop them in detail as the relationships among them were explored. The particular categories that emerged include Context and Locations, Social Relations, Social Distance/Body Pose, Activities, Interaction, Spatial and Structural, Cultural forms and Intent. For the purpose of this paper, only one of these categories will be discussed in detail.

Context and Locations

All of the children provided a range of localities in their images. Spaces included indoors and outdoors, as well as spaces that could be identified as specifically "owned" by the children. Overwhelmingly, children included images of their bedrooms. These ranged from bare-floored communal sleeping sites inside Zambian homes to designer bedrooms in Australia and the U.S.A. The images ranged from tiny snapshots of bookshelves containing important trinkets to panoramic views of the rooms. Images of family members looking relaxed were provided, sometimes set in the kitchen, the lounge room or other locations inside and outside the home. Family photographs were generally posed but taken in informal settings. The images of Australian children (both urban and remote) involved large stretches of natural environments—bush landscapes and open areas (for example, note the image in Figure 1). This was in contrast to children from other countries who typically presented landscapes in which figures (family and friends) obscured the environment. Schools, exteriors and interiors of classrooms featured in most of the images, with the exception of those submitted by children from Zambia.

Figure 1

Reading the Text

Whilst the images in the project hold tremendous visual power, allowing an exploration of culture (Ball, 1997), the written word provides a complementary dimension that can be read alone or in conjunction with the images. The children were invited to produce written accounts of their immediate worlds as well as providing a commentary of their global concerns, incorporating their experiences at the personal as well as the cultural level. Michael Crotty (1998) notes that written responses can be read as narratives when they incorporate personal stories as well as their cultural locations. As Crotty (1998) observes, a personal story presents "the voice of our culture—its many voices in fact—that is heard in what we say" (p.64). Rather than simply providing captions for their images, a requirement that may have limited both the images they captured as well as the written responses they constructed, the children were requested to provide personal information about their immediate environments, their families and what they enjoyed doing. In addition, they were asked to comment on global issues, providing opportunities for the development of critical thinking.

Currently, one hundred and eighteen booklets have been returned with all but four containing written responses. The written responses were initially categorised by location and responses to the six questions included in the booklets were scrutinised on this basis. In addition, responses were also categorised on the basis of age and gender. With regard to age, at the times when their responses were submitted, the ages of the participants ranged from 6 to 18 years. Responses were categorised according to one of three sets of age ranges: 5 to 8 years, 9 to 12 years and 13 years and above. Participants were also identified as either male or female. The written responses were coded using key terms drawn from the data and, as analysis across locations progressed it became possible to identify various patterns, with broader themes emerging as more data became available. Some brief comments will be made regarding general response patterns across location, age and gender before an outline of the emerging themes that have been identified is presented.

General Response Patterns: Location, Age and Gender

These three categories, location, age and gender, whilst useful for grouping responses, are not entirely independent of one another and their intersections are often informative. Nevertheless, based on these categories,

patterns have emerged with regard to the ways in which participants have written about their experiences. The following summary provides a brief account of some of these patterns.

In terms of location, a child living in a remote community will have different access to communication, transport and leisure facilities than a child of similar age living in a bustling city. Access to these facilities shapes interactions with others as well as the nature and range of activities in which it is possible for the child to engage. For example, where daily experiences are less dependent on the natural environment, the use of technology assumes increasing significance. Children from the more remote communities in Western Australia and Zambia made limited reference to the ways in which technology played a part in their lives. Only one youngster in Western Australia, for example, mentioned watching movies on television. This is not to say that technological advances are not important to these communities but it may reflect the degree to which children in remote areas have access to items such as computers, televisions, video games, the internet and hand-held telephones. On the other hand, these items are mentioned frequently by children in urban Australia, Malaysia, Thailand and the U.S.A.

When age is included as a basis for examination, patterns emerge within age groups. For example, there are common elements to the ways in which young people aged 9 to 12 years interact with one another, regardless of location. The nature of their leisure time and their interests in sporting activities attest to common pursuits. On the other hand, a difference in age-related skills was evident with regard to literacy, with shorter responses generated by children in the younger age group and longer, more detailed responses given by older participants. Other differences were also evident from a developmental perspective. For example, children in the 5 to 8 years age group tended to respond in ways that reflected a marked degree of egocentrism, whilst in the two older groups respondents were more likely to recognise and understand the perspective of others. A clear example of this difference can be found in the words of a young child living in a country town in New South Wales, Australia who, in response to the question about what he might change in the world declared:

> *"I want a McDonalds".*

This somewhat hedonistic statement stands in contrast to the response of a child in the 9 to 12 years age group living in the U.S.A. who wrote:

> *"If I could change anything in the world it would be to make sure everyone had enough money to have clean food, water, medicine, clothing, and a home. I read that around the world one billion people don't have these things. These people are suffering from disease other countries have completely eliminated."*

The older child can understand and empathise with people on a more global scale, assuming a perspective that draws on a range of knowledge and experiences not yet possible for the younger child.

When responses are categorised with regard to gender it is again possible to identify differences as well as common elements. For example, both girls and boys refer to the importance of family and friends in their lives and, in the majority of cases, they refer to the roles of parents and, at times, themselves in traditionally gendered terms. With regard to difference, whilst both groups acknowledge their involvement in informal as well as organised and competitive sporting activities, a higher proportion of males in NSW, Australia and Zambia responded with reference to these activities than did females in these locations. In these two locations, all of the boys mentioned their engagement in sport compared with less than half of the girls. In addition, there were some differences in the sports that both groups identified. Girls, for example, were more likely to mention non-contact sports such as dance and gymnastics than boys were.

Emerging Themes

A number of themes have emerged from an analysis of the written data so far and, in certain instances, they share common ground with themes emerging from the images. These themes continue to be shaped as other questions are asked of existing data and as new data becomes available. At this point three themes are noteworthy in that each demonstrates different dimensions of the lived experiences of the children who have taken part in the project. A brief overview of these dimensions is included here.

A sense of place and space: Shaping the contours of experience

A sense of place and space is evident in the responses that have been gathered so far and, in some respects, it shares elements of the visual images discussed earlier in terms of Context and Location. It embodies the ways in which experiences are shaped on the basis of the sense of place and space that the individual develops in relation to where he or she lives.

Tom Anderson (2003) writes about the ways in which differences between the constructed or built environment and the non-constructed or natural environment shape our development. He argues that the lives of many people in the world are lived in constructed environments and that the sense of space we each develop "is mediated by our constructed milieu…[to the extent that, in our separation from the natural environment]…our own constructions become our world" (Anderson, 2003,p.6). Both images and text reflect this viewpoint, with written responses from young people in remote environments suggesting a greater affinity with their natural surroundings than those who live in urban areas. On the other hand, young people living in built environments write confidently about the constructed landscape in which they negotiate their daily lives.

Sharp contrasts were evident between responses from children living in a remote indigenous community in Western Australia when compared with children of similar ages living in urban and inner city areas. One of the children from Western Australia describes her home in the following terms:

> *"Near the great sandy desert is Kadjina community and that's where I live. The sand is red and the weather is hot. The grass is prickly and called Spinifex."*

Her words evoke the sense of space, the colours and the conditions that prevail in her home territory and, in conjunction with responses to other questions, it becomes clear that the environment shapes many daily experiences of the children living there. The activities the children undertake together as well as with their families reflect a connectedness with the natural environment. Another child writes:

> *"My mummy and daddy are really good cooks. My daddy is a really good hunter. One day he got 9 goannas."*

Catching goannas is never an easy task and one that children in built environments are not likely to experience! By contrast, a young boy living in Bangkok, Thailand, provided a description of his home that focussed more readily on built structures as landmarks than features of the natural environment:

> *"My home is at* [formal address specified]*...I live in the village near a hospital, school, market and department stores. There are almost 10 temples near my place."*

Half of the respondents from Thailand included their formal addresses as descriptors and the activities they described, which they typically shared with family and friends, were more likely to involve elements found in built environments. For instance, they describe activities such as bike riding in a park or going shopping with friends, or else playing sports that require access to particular facilities and equipment that may be less available in remote communities housing a smaller number of people.

A brief description of a home in Zambia presented another view of how lives may be lived against a background of structures quite different to those mentioned by children in other locations. One boy wrote:

> *"I live at a small place called* [name of company]*, a ten acre area with few boss houses and a big compound with about 20houses for workers. A factory is in it fenced with electrical wire."*

The frugal nature of life in a compound within a relatively sparse landscape is borne out by references to the importance of a vegetable garden and livestock in other responses.

Whilst all of the written descriptions provide the reader with a sense of place and space, accompanying images present a rich background against which interpretations of these responses may be made.

A sense of others: Developing empathy and compassion

An overwhelming number of responses, irrespective of location, age or gender, in relation to the question "What's good in the world" involved a sense of compassion for those in need. Not only was there an acknowledgement of suffering and the impact, in particular, this may have for other children but there was also recognition that one of the good things in the world involves people helping other people, irrespective of the boundaries that commonly define different groups. More detailed responses were provided by young people in the two older age groups but even the responses of the youngest children reflected a sense of altruism.

A number of responses mentioned unusual events that had caused devastation, such as the tsunami in south-east Asia and Hurricane Katrina in the U.S.A., and the relief that was provided on a world-wide basis. Other responses indicated that children and their families were aware of and, in some instances, involved with local groups who responded to the needs of those in their own communities. At a personal and global level, the importance of helping others was viewed as a priority.

With regard to recognising the plight of children in different areas of the world, a participant from Penang, Malaysia stated:

> *"I will stop child labour in India and Pakistan…I would also stop the war and starving of children in Africa and Iraq…children become victims of war and suffer the most…People living in these countries also become victims of HIV and AIDS and again children suffer the most."*

Other responses from children echo the sentiments involved in helping those in need, often with a hope that those who cause suffering to others can be changed from "bad people" into "good people".

A sense of powerlessness: Living in fear

Responses to the final question regarding their wishes for changing the world, led many children to write about the dangers they perceive, whether from terrorism, drug dealing or war, as well as their desire for peace. For some, the call for an end to war was couched as a plea, at other times a command, but a common element of the responses was the fearfulness this topic invoked, reflecting also perhaps the sense of powerlessness a child experiences in a world of adults. A young child from Bangkok, Thailand stated quite simply:

> *"There are bad people in the world. So, we live in fear."*

A direct experience of war was evident in the response of one young girl living in Penang, Malaysia, who described the change she has encountered after leaving her country of origin, Iraq, to live in a safer environment. Her story continued in terms of how she might change the world:

> *"There are three things that I would like to change in this world. First, to stop any war especially in my country (Iraq) and stop the killing of children. Second, no more poor people. Third, to build a big building and put orphans in it and take good care of them."*

The simplicity of her statements belies the depth of her first-hand experiences of war and its effects. A response from a child in Illinois, U.S.A. also demonstrates the fearfulness of the situation when war becomes personal:

> *"If I could change anything in the world it would be for peace on Earth. Not just that but that the war in Iraq could end because my cousin is there and I am very scared for him…"*

With regard to conflict and the tragedy involved in it, a young girl from NSW, Australia stated the case quite clearly and offered a solution:

> *"Human conflict is the biggest problem in the world. If humans weren't so ignorant then there wouldn't be wars with millions of innocent people being murdered because of their race. Maybe this can be helped by education because if people come to learn about others they may come to appreciate them."*

Children recognise the dangers inherent in criminal activities and in the war. They appreciate the implications for others and, where they are touched personally by these experiences, they can explain their fears quite rationally.

Conclusion

Voices of Children highlights the ideas and experiences of children across the world, integrating personal experiences that are culturally located with basic technology that is readily accessible. The images and text they have constructed are representative of them as individuals and also of their surroundings and relationships. They are empowered through the choices they are able to make in terms of the ways in which they present their experiences and, at the same time, their responses provide expressions of their particular cultural perspectives (Prosser, 1998). Additional features of this project such as the travelling exhibition and the website honour the contributions of the children as artworks whilst providing a range of ways in which the participants and others can engage with the images and text that have been submitted. The voices that emerge through this project reflect the many dimensions of children's lives, their common experiences and concerns as well as the conditions that divide them. Importantly, as a collective, their voices reflect a promise for the world we all share.

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Effectiveness of Using Podcasting in Curriculum Delivery

Shawn McCombs, M. Ed.
Youmei Liu, Ed. D.
University of Houston

Abstract

iPods have become a cultural phenomenon. Not only do they serve as a mechanism by which to identify the Net-Geners, Millennials, and now post-Millennials (nicknames given to today's students), but they also hold valuable promise as a means by which to reach students bombarded by fragmented learning environments, multitasking, and a world in which people are always connected. This paper discusses the research results and analysis on using Podcasting in curriculum delivery and focus on two issues, 1) the impact of Podcasting technology on student learning, and 2) course design issues involved in instructional delivery via Podcasting.

Introduction

Finding innovative methods to reach students is becoming increasingly difficult and even challenging. Today's students, aptly dubbed the "Net-Gener" by leading scholars, are inherently more sophisticated than we were at their ages and have pushed the "convergence" catchphrase to the limits of its very definition – the coming together of various media types. In the Fall of 2005, various units within the University of Houston (hence UH) joined forces to begin a thorough research study investigating the benefits of Podcasting in the distribution of curricular content and understanding the efficacy of such tool in the modern classroom. This research project was based largely on the feasibility that iPod can be an effective portable learning tool to enhance student learning. Capable of on-demand media delivery, Podcasting made the connection between education and students via this portable learning device.

The Study

A survey method was used to conduct this study for the purpose of analyzing student perception and behavior associated with instructional delivery via Podcasting. Phase I of the study found four classes participating: one section was delivered completely online; the remaining sections utilized WebCT Vista as an online course management system. The total enrollment in these four classes was 200. Nearly 80% (N=165) of the students participated in the study. Instructors used Podcasting to deliver course lecture materials or supplement materials as alternative channel to facilitate student learning. The study specifically investigated the areas discussed below related to Podcasting of course content materials and use of portable devices as leaning tools.

There is no question that iPods have become as commonplace as the cell phone in our student's lives. In fact, the simple exercise of observing students walking between classes or sitting outside on benches or in other social areas across campus reveals little white ear buds everywhere – an obvious sign of the time. In addition to offering students an efficient method for listening to music, podcasting allows educators a unique opportunity to meet students in their own, comfortable environments. And these opportunities do not only exist in the various types of lecture and/or addendum content that we can make available, but also exists in three basic categories of podcasts as well.

The success of phase I of the UH Podcasting pilot and research study yielded valuable data surrounding student's use of iPods, Podcasts, and perceptions associated with usage. Looking closely at both functional and ritualistic applications of iPod use, students at the School of Communication at UH generally preferred iPod over other MMDs, and though the ratio of iPod to other MMD use was nearly three to one, there was no significant difference in how students used the various devices to consume podcasting content, as well as music and other media types.

iPod users clearly dominate the sample. Student reported using iPod more than other MMDs, with 69% of them preferring iPod to other MMDs. While generic mp3 players comprised in insignificant proportion of the overall MMD population, it is important to note that, of the 69% of the students who had iPods, that the type of iPod used by students varied to some degree (Table 1); there was no real winner, though it was impressive to note that a fair amount of them had 5th Generation video iPods, which helped in the analysis of Vodcast (video podcast) use in instructional delivery.

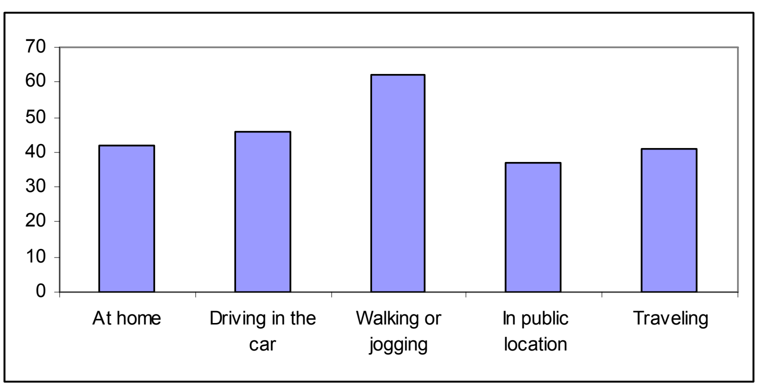
Table 1 *Frequency Table of Different Models of iPod Owned by Students*

iPod Model	Frequency	Percent	Cumulative Percent
Fifth Generation iPod	23	23.2	23.2
iPod nano	25	25.3	48.5
iPod with color display	2	2.0	50.5
iPod photo	2	2.0	52.5
iPod shuffle	11	11.1	63.6
iPod click wheel	4	4.0	67.7
iPod mini	17	17.2	84.8
iPod touch wheel	13	13.1	98.0
iPod scroll wheel	2	2.0	100.0
Total	99	100.0	

Student iPod / MMD Usage per Week

Most of the students in the pilot reported that they used their iPods and MMDs 20 hours per week or less, with almost 37% using iPod just five hours per week, nearly 19% using theirs between five and ten hours per week, and 24% between 10 and 20 hours per week respectively. The preferred time and location that students used iPod was almost as varied as the number of options available for them to identify. The data indicate that students found a wide variety of opportunities to use their iPods: whether at home, driving in the car, or exercising, students were almost evenly split when it comes to preference (*Figure 1*). This suggests that their podcasting use in education could leverage the benefits of the device's mobility with the habits of use by students.

Figure 1 Student preferred time to use iPod (in percentage)



Preferred Activities with iPod / MMDs

Listening to music is the major use of iPod among students. But, let us not forget the original intent for the little devices: they were, after all, originally conceived for music organization and mobile listening. Technology has advanced enough in just five short years to allow the viewing of both images and now video – a major advancement in mobile media device delivery. Though most certainly the best is yet to come, one cannot ignore the amazing potential that iPod brings to the classroom and lecture hall. While only 7.5% of those surveyed reported they preferred using their MMDs for academic content delivery, the fact that most still preferred using them for music is not surprising or even unexpected.

Podcasting Course Materials

After reviewing student preferences with respect to overall use of iPod and MMDs, we can now examine the academic use of podcasting and student perceptions and behaviors surrounding such use.

Methods for Podcasting Playback and Consumption

Whether at the gym or on the beach, there are no real clear-cut winners in the various activities where students use their iPods or MMDs. However, when students are using iPods or MMDs for academic purposes, it is clear that podcasting makes contribution in the manner in which students are studying. Though viewing podcasts and other curriculum materials on the computer represented the majority of consumption methods, downloading academic podcasts to MMDs became an increasingly popular activity over 31% of the time (Table 2).

Table 2 *Methods Students Used to View Podcast Course Materials*

Methods to View Podcasts	Frequency	Percent
Viewed materials on a computer	108	62.8
Downloaded materials to iPod	54	31.4
Downloaded materials to other MP3 player	6	3.5
Burned materials to CD for playback on a portable CD player	4	2.3
Total	172	100.0

Time Spent Using iPod or MMD with Academic Podcasts

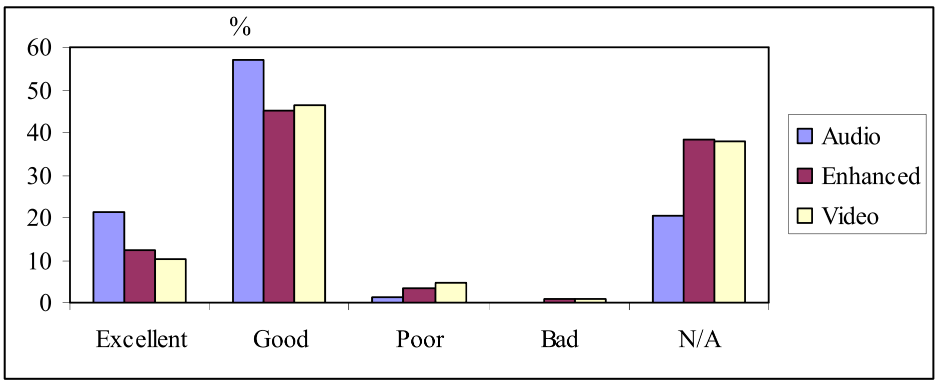
Though students preferred using iPod and other MMDs primarily for music, they overwhelmingly supported using these devices for consuming academic podcasts and other class materials. Even with general approval, it is interesting to note that more than 75% of those who used podcasting content on their iPods did so for five hours or less per week. This would suggest that students reviewed and consumed podcasting content primarily on the computer, but used the iPod as a means to review or consume on the go, offering mobility as an option for extending the delivery channel from the constraints of the computer.

Of the 127 students who said they used the iPod or MMD for reviewing or consuming academic podcasting content, over 17% did so between five and ten hours per week. This is a significant number which suggests that a large segment of the population found the additional delivery channel to be an effective resource in lecture or addendum content delivery. Additionally, less than 5% of those who used the iPod for this purpose did so ten or more hours per week, with nearly 1% doing so between 20 and 30 hours weekly. While this may seem extreme, those who commute via public transportation (or other methods) could easily find that time period optimum for use.

Perceived Quality and Preferred Podcasting Formats

Perhaps one of the most often overlooked components of podcasting is the need to generate quality content from the outset. Given that students will likely be consuming academic podcasts in a variety of settings, it is imperative that they be produced in a manner that will allow for efficient delivery while preserving resources. Because podcasts are actually downloaded to the users computer and ultimately to the iPod, file size and compression can make the difference between a 5-minute download and a 25-minute download seem like an eternity. One of the biggest challenges that those who encode and publish podcasting content face is trying to apply the appropriate compression and encoding settings so that consumers find the minimal download time. One problem with this, however, is that the greater the compression and encoding, the greater the degradation of the final product. This is especially challenging for video playback and consumption, especially for academic content that involves instructor examples, such as math, accounting, statistics, or other classes where it is important that the student be able to see playback clearly.

Figure 2 Student perceived quality of podcasts in different format



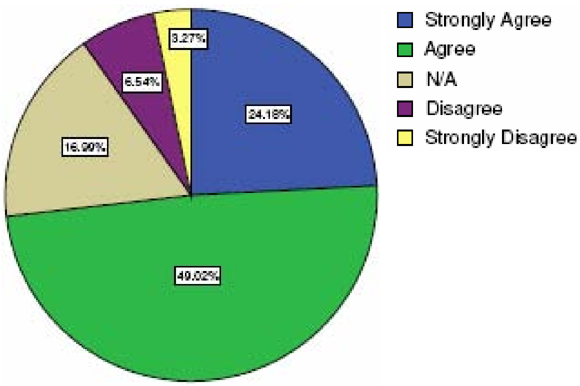
It was extremely important in this pilot, from the beginning, that quality of content was addressed and evaluated throughout the process – and, in most cases, before students were exposed to the content themselves. To accommodate theses activities, a Quality Assurance team was included in the organizational structure of the pilot with the primary responsibility of monitoring both publishing methodologies as well as playback quality of all podcasting formats. Knowing, then, that we had quality product from the outset meant that we were able to focus on unadulterated feedback from participants who might have otherwise been biased because of poor quality playback.

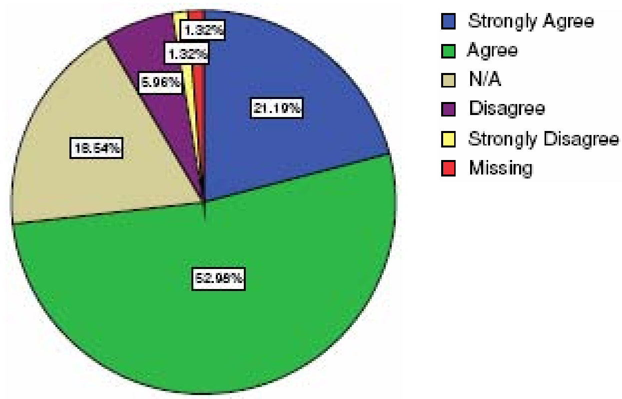
Feedback from students suggests that audio-only podcasts were thought to have the highest quality, with video coming in a close second. Enhanced casts rounded out the three, though all formats received relatively high marks for quality. While the question posed was initially meant to gage their perception of the quality of the product, it is worth mentioning that students may have associated quality of the podcasts with the preferred format for consumption.

Clear and Effective Instructions

One of the most important components to Podcasting is providing effective and adequate instructions for consuming academic content through podcasting. These instructions should include, at the very least, the URL (feed) for subscription to the podcasts, as well as alternate options for receiving the content. In addition, the instructions should most certainly be made available electronically, through course management tools or other electronic syllabi. Given that the medium is produced and consumed online, making the instructions for consuming them available in the same medium is highly recommended. In this study, student feedback on the instructions given was collected for effectiveness and future improvement (*Figure 3 & 4*).

Figure 3(left) The instructions to access the podcast course materials were clear
Figure 4(right) The instructions to access the podcast course materials were easy to follow



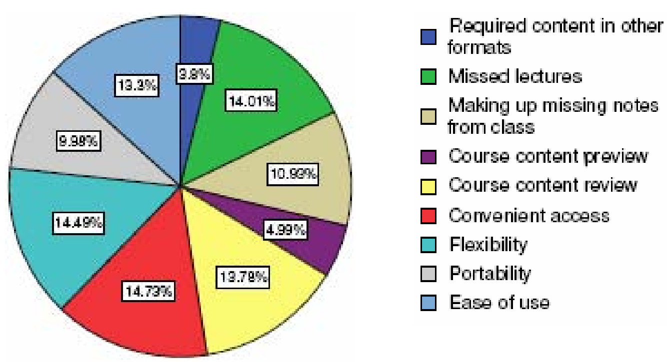


The instructions used in phase I of the pilot were standardized for the most part, and students were given the same instructions for each class, with only feed URL being customized for the instructor of record. The overwhelming majority of those polled responded that the instructions by instructors were both easy to use and understand, as well as extremely helpful in the subscription process.

Reasons for Using Academic Podcasting

One of the greatest challenges we face as educators is ensuring that our students have equal access to content, even when those students cannot always be in class. Podcasting can be a tool to help in this process, providing a mechanism for students to gain access to materials when they otherwise would not be able to do so. Like the times and places that students prefer to use iPods, the reasons that they used podcasts are almost as equally universal. Having no clear preferred reason, students found benefits in all classifications made available to them for selection (*Figure 5*).

Figure 5 Student reported reasons to view podcast course material



Student Perceptions and Experiences with Podcasting

One of the important aspects investigated in this study was to find out student perceptions towards educational use of Podcasting. The above-mentioned data indicated that majority of students are using iPods or MMDs for entertainment. Delivery course material through Podcasting is still relatively new to students. Their first podcasting experiences are very important for instructors to integrate this technology effectively. The following group of data shows the effect of podcasting on student learning experiences from different perspective.
Podcasting and Learning Styles

Learning Style Theory has been considered as an important factor for developing effective teaching strategies and methods. Since Podcasting can be presented to students in different formats, audio, enhanced, and video, this technology can help instructors respond to student diverse learning styles by creating rich learning environments that engage students with auditory as well as visual learning styles. In this study, the data indicate that there are more than 43% of students self-reported as visual learners, and this group is followed closely by 41% of tactile learners. Auditory learners take up 15% of the total number of students. When students were asked which podcasting format best suits their personal learning style, video podcasting (visual learners) takes the lead with close to 60% of respondents. The data provide valuable feedback for instructors on podcasting delivery format.

It should be noted that even though Vodcasting is favored by students in this study, in reality, the production and playback of Vodcasting have higher requirements for both instructors and students as compared to audio podcasting. For instructors, it involves video taping, editing, and encoding, etc., it could be very time-consuming process; and for students, they need portable devices that can display video images. The format selection should be determined by the content analysis. If audio format can satisfy student learning, there will be no need for instructors to go through the lengthy process. But the data are very good indications for future podcasting development when technology are advanced to the point where requirements will not be so demanding for both instructors and students.

Podcasting and Study Habits and Patterns

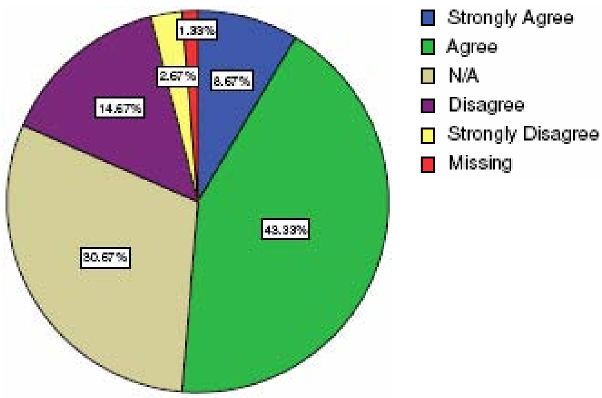
The availability of technology affects people's life. We can see people's living habits and behavioral patterns changing with the development and advancement of technologies. For example, since online education became available, quite a few students no longer attend regular on-campus classes. They access learning content and interact with their instructors and classmates virtually. Podcasting technology has created a new instructional delivery channel. In this study, there are more than 32% of participants reported that the availability of course material podcasts changed their study habits; and about 30% of students stated that podcasting changed their behaviors outside of the classroom when studying for exams.

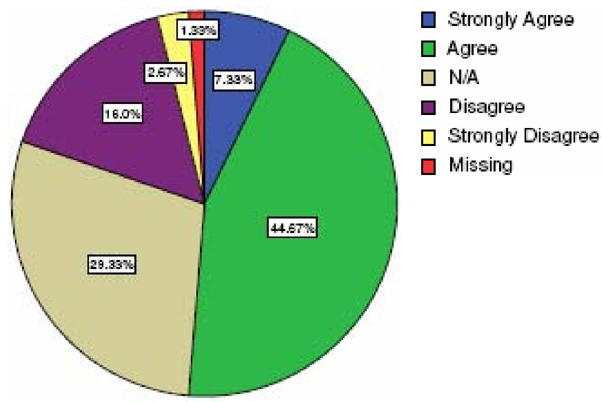
The integration of podcasting for instructional delivery also affected student's study time allocation. About 23% students reported that their study time decreased with the addition of podcast for content delivery. More than 30% of students reported that their reading time decreased with addition of podcasts. Since listening or watching podcasts is individual learner-centered activity, more than 51% of students agreed that learning via podcasting increased their study isolation and 31% of students reported that podcasting delivery decreased the involvement of community of learning. One of the suggestions made by students is that podcasting should be integrated with other learning activities. These data provide a very good guidance for the effective instructional design via podcasting.

Podcasting and Student Learning Experiences

Student enjoyment of the course is positively related to their learning attitudes and to their perceived value of the course they take (Patti & Saroja, 2005). Learning enjoyment also has been explored to design game-based instructional delivery to motivate and engage student learning. iPods and MMDs have been used for entertainment. The study data indicate that most students' primary use of their portable devices is to listen to music. Will the enjoyable experiences transferable to their learning process? More than 53% (*Figure 6)* of students stated that podcast course delivery format made their learning more enjoyable. Approximately the same amount of students, 52% (*Figure 7)* reported that podcast delivery format enhanced their learning experiences. The best types of engagement stem from the learner's enjoyment of a more effective learning experience, one that puts them in control and encourages active participation, exploration, reflection and the individual construction of meaning (Galarneau, 2005). Podcasting is becoming a mutual communication tool instead of one-way delivery tool. Instructors can take advantage of this delivery media to possibly improve student learning effectiveness.

Figure 6(left) Podcasting made learning more enjoyable
Figure 7(right) Podcasting enhanced student learning experience

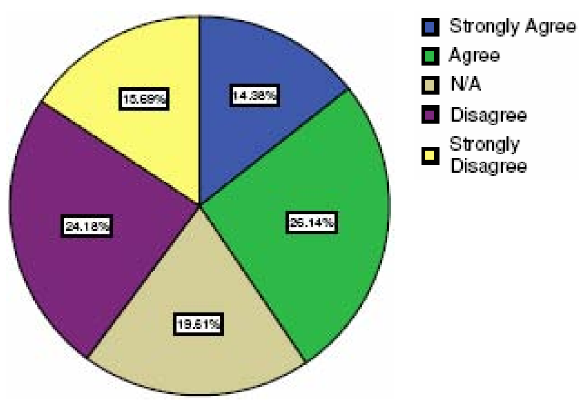




Podcasting and Student Class Attendance

The most valuable features that students found with podcasting were flexibility and mobility. The data show that more than 83% of students favored with these two features because these features fit perfectly into their living condition and dynamic life style. University of Houston is a large urban commuter school. Majority of students have either full-time or part-time jobs. They spend a lot of time on the road driving to school and struggling to find a parking spot. This is especially difficult for morning class students. Our study indicated that the students who had morning class preferred podcasting to attending class lectures. When the morning class instructor started to deliver the full class content via podcasting, more than 85% of students accessed podcasting material instead of coming to class. For the other afternoon class, majority of students still attended class regularly. Besides, the afternoon class used podcasts as supplementary materials to lecture content. This is the reason that the following Figure 8 shows the percentage of students who preferred podcasting (40.52%) is almost the same as the students who preferred lectures (39.87%). More than 65% of students preferred the combination of podcast content delivery and face-to-face learning experiences.

Figure 8 Student preference of podcasting to attending lecture class



Podcasting and Learning Effectiveness

The ultimate goal of integrating podcasting in education is to provide a new instructional delivery channel to facilitate student learning and to improve their learning outcome. The quality course design is not determined by teaching or designing experts but by students, if they learn, how they learn and what they learn. Podcasting delivery quality directly affects student learning quality. The following data reflect student's perception towards podcasting quality and their learning outcome.

Podcasting Design Quality

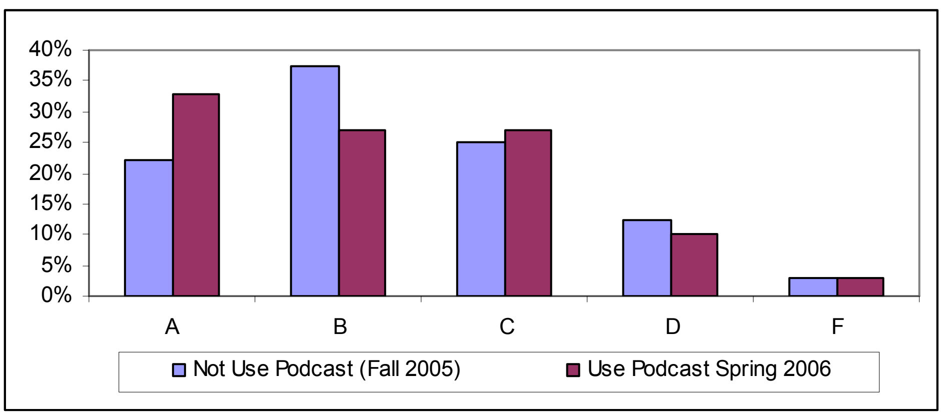
Podcasting design quality was measured through content delivery accuracy and clarity, logical presentation, as well as the integration with other content and activities. In this study, with four classes, more than 73% of students reported that the podcast material content was clear and easy to understand. More than 71% of students agreed that the podcasting content was presented in logic order. More than 72% of students reported that the additional podcasting material was relevant to course content. More than 70% of students indicated that the podcasts were well-integrated with other class activities. Those class activities included discussion board posting, hands-on projects, group activities, and varieties of assessments.

Podcasting and Leaning Effectiveness

In this pilot, Podcasting was used for both full course content delivery and supplementary to lecture content to facilitate student learning. More than 66% of students reported that the addition of podcasting material was helpful to the understanding of course content. More than 59% of students indicated that listening to podcasts helped them better retain the content information.

Last but not the least, when students were asked if the use of podcasts improved their grades, more than 26% of students reported positively. Figure 9 shows the grade comparison between the two fully online classes with same content material and taught by same instructor. Fall 2005 class did not use podcasts, while Spring 2006 class used podcast. There is a 12% increase with A students, and overall performance has been improved with the class using podcasting. The comments from students in the survey are also very positive in using podcasting for instructional delivery.

Figure 9 Grade comparisons between two classes



Podcasting Best Practice Generated from the Study

Here are several recommendations based on the data collected from the research study regarding relating to effective integration of podcasting technology in instructional delivery.

1. Always have a back-up plan. Podcasting should not be the only delivery channel for instruction. You can implement it together with other delivery media, such as streaming, and CD/DVDs. Do not forget text, which is always the safest way to prevent any technical difficulties. The study results indicate that the students who had dial-up Internet connections had problems downloading large file size video podcasts; some students had limited storage space on their MP3 players for a full-length lecture podcast. Preparing material with different formats can satisfy different users and guarantee every student equal access to the course content.
2. Re-structure the content, and "cut" it to meaningful segments for effective delivery. Keep your podcast short, especially a video podcast (Vodcast). For an audio podcast, it should be under 30 minutes, for an enhanced podcast, under 20 minutes, and for Vodcast under 15 minutes. Several issues arise when using long podcasts. It takes longer a time to download the content; it takes up more space to store it, and some MP3 players have limited battery power.

3. Incorporate other learning activities with podcasting content delivery. There are varieties of learning activities that can help recall the information delivered via podcast, such as discussion forums, assessments, projects, etc. Faculty members can also create learner-centered activities to improve students' ability to apply knowledge application. They may also provide students opportunities to re-construct the information for better understanding, and strive to find out the best teaching pattern favorable to student learning.
4. Make the Vodcast complimentary to the information rather than replication of the information. Effective use of the video images can greatly increase the stimuli of the information to the learner's brain. Instead of showing a "talking head" on the screen, extra visual information related to the content can enhance the learning effect by triggering new focus and attention. Do not use technology for the sake of technology.
5. Use the lowest format to achieve best results. Here, lowest format means an audio only podcast. When you analyze the content, start with the lowest format of delivery. An audio Podcast has a smaller file size and takes less time to download. In addition, you can reach more students. The study results from the UH School of Communication show that more than 65% of students own iPods or IM3 players, but only one third of this population has an iPod with video capabilities. You should choose enhanced formats only when they can provide additional value to the content; otherwise, the audio Podcast is just as good as (or better than) the others.

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CONNECT TRAINING AND WORKPLACE EXPERIENCES: USING A REAL-JOB PROJECT APPROACH TO TEACH INSTRUCTIONAL DESIGN AND TECHNOLOGY

Xiaopeng Ni
Michael Orey
The University of Georgia

Abstract: This study investigated the effects and challenges of a real-job project approach as pedagogical and curricular strategies in an instructional design and technology training program. Using questionnaires as a research tool, the study surveyed experiences and perceptions of professionals who graduated from the program in more than 30 business and industry areas. The results show that trainees reported positive benefits through the real-job project approach, although the rate at which they had applied their projects in workplace was far below expectations. While this approach allows participants to initiate responsive solutions to their job settings, five elements (project vision, formative assessment, responsive activities, technology scaffolding, and workplace client) merit further consideration to help trainees develop more successful projects and exert greater impact on their workplace.

Introduction

Professionals are in a world of continuous change and innovation, and this is especially true for the field of instructional design and technology (IDT), where professionals need to utilize emerging technologies and design principles to provide new educational solutions. Training has been seen as a common means to keep today's employees secure and competitive in a rapidly changing workplace. However, the traditional lecture-based training approaches have a low transferability of knowledge and skills to the trainees' working place. Such perceptions are prevalent in the training field. Georgensen (1982) made an assertion that only 10% of the training investment has been translated into employees' job performance. Shaw (1995, p.62) shares a similar observation, "As much as half of [the money American corporations annually spend on formal training] is being utterly wasted." In addition to other reasons, such as training aimed at non-training problems, one major reason for the failure of training is its poor pedagogical design. Haskell (1998) claimed that the traditional, industry-based methods of training are inappropriate and unworkable for the fast changing, knowledge-based organizations. Today's organizations must find ways to give their employees customized, thought-based, and task-extended training, instead of uniform, simple rote, and task-limited training.

This study examined project-based learning incorporating real-job tasks in an instructional design and technology (IDT) training program. A real-job project approach is conceptualized as project-based learning incorporating trainees' job components into their training process. The term "a real-job project" is introduced to reflect the integration of authenticity in a project approach in the instructional context. This study investigated whether this real-job project approach could serve as an effective training strategy providing customization, relevance, usefulness, engagement, and application to the workplace, and how we can improve such a training design for future or similar IDT programs.

Description of the Certificate Program

The Instructional Design and Technology Certificate (IDT) Program was conceived to serve training professionals in a nearby metropolitan center as part of a college-wide outreach initiative. The goal of the IDT training program is to assist professionals in various organizations to better use the knowledge and skills of instructional design and technology in their working contexts. The training content is organized around the analysis, design, development, implementation and evaluation (ADDIE) paradigm for training development. The pedagogical framework for the IDT certificate program is built upon project-based learning and a job task from trainees' workplace. This five-weekend training program, a total of twelve hours each weekend, is designed for professionals whose current or future job responsibilities involve designing training within an organization. The participants in the IDT program include trainers, managers, human resource practitioners, and other professionals responsible for training services. The training program is offered every spring and fall semesters and lasts five weekends, a total of

fifty-five instructional hours. Ten training sessions have been conducted to date and more than 100 people have participated in the program. There appears to be a perception of success.

The training sessions are organized to support the project progress although no instructor is directly responsible for the project. Each session covers a different topic in the field of instructional design and technology. The topics covered are illustrated in Figure 1.

Topics in the IDT certificate program
1. Introduction to the field and the theory of instructional system design
2. Analysis: needs analysis, task analysis; trainee analysis; performance analysis
3. Design: create the blueprint, storyboarding, tool choices
4. Development: message design; development tools; studio experience
5. Implementation: E-learning issues, case studies
6. Evaluation: usability testing; evaluation plan and tool
7. Others: adult learning; project management; training proposal

Figure 1. Substantive course topics.

The trainees were introduced to the IDT training program and informed that the training is organized around a real world project by the program chair during the first week. They were invited to begin thinking about a software tool to learn, Authorware, Dreamweaver, Captivate, or Flash (the choice is subject to change from semester to semester). The rest of this week was to introduce trainees to the field of IDT, the ADDIE model, and instructional analysis.

The focus of the second week was mostly about analysis including an analysis workshop, case studies of instructional design, adult learning theory, and project management. Trainees worked on their own training issues as class exercises, and heard real stories from industry and business. The adult learning session helped them be aware of adult learner' characteristics and apply instructional principles for adult learners. The project management session helped them manage a typical project management plan.

The third week was mainly about design and evaluation. The goal for this week was for materials to be produced on screen, like the color issue, font issue, and sequence issues, and trainees began to work on a storyboard for their ready-to-go product. Evaluation planning, tools, and usability testing were also covered during this week, although in trainees' projects the evaluation part is never actually included.

The fourth week mostly focused on development. Trainees worked in a computer lab, learned software tools, and developed online-prototypes. The class was broken up into groups based on the tools they had chosen to learn. Each group had an instructor to lead with a software book. They were located in the same computer lab, but generally trainees who worked on the same tool sat close to each other. From Friday to Saturday, instructors moved on to more advanced functions to help trainees develop their projects. Some student volunteers in the instructional technology department also came to help trainees with their tool learning.

On the fifth weekend, trainees spent most of their time on their project work in the lab. A session about trends in the e-learning industry and a session on training proposal writing were scheduled. On Saturday morning, project presentations were scheduled and each trainee presented on his or her own e-learning product for around 15 minutes. The presentation served as the culminating activity of the project. After that, a graduation luncheon was served and the certificate was presented.

Design Characteristics of Pedagogy

In order to help those professionals in various organizations effectively apply the knowledge and skills of instructional design and technology, the considerations of the design of the program were given to blending authentic learning, project-based learning, and the nature of instructional design. Specifically, the pedagogical characteristics underlying the training program are:

a) *The certificate program offers trainees the opportunity to choose an authentic project that is meaningful to trainees.* The training is not a technical skills oriented program, but, rather, is intended to prepare trainees to effectively address and manage their training efforts. Trainees are encouraged to develop an authentic project related to their real-life working contexts so that they can apply the knowledge and skills they have learned. This characteristic allows the trainee to solve the real problem by hands-on doing.

b) *The training is organized following the framework of the ADDIE model.* ADDIE is a generic model of instructional design, which consists of five phases of Analysis, Design, Development, Implementation, and Evaluation. It is a well-known model for developing new training programs. Both the IDT program and the

project are built around this model to give trainees a sense of workflow in the community of practice. This characteristic makes sure that different sessions and learning tasks are organic connected and the framework lays out a core basis for the expected expertise.

c) Instructors in the training program present theories from the academic world and stories from the real world as well. Another distinguishing characteristic of the IDT training program is the diversity of instructors. They include both faculty members from the university who conduct academic research and professionals in corporations who apply knowledge of instructional design and technology in the field. Including various speakers from the fields allows trainees to be familiar with IDT applications in fields and therefore, facilitates their own problem-solving skills.

Methodology

This study was designed to help us better understand the effects on participants' experience from using the real-job project approach in the training context. It was also designed to provide ideas about how we can improve this approach in the context of training IDT professionals. Specifically, two questions were asked: What are the effects of a real-job project approach on trainees' experience of learning instructional design and technology? What challenges do trainees encounter during the various stages (project initiation, project development, and subsequent workplace applications) of real-job project-based learning?

This study employed online questionnaires as the primary method of data-collection. The questionnaire consists of both Likert-type and open-ended questions. The items in questionnaire include: choice of project; trainees' entry levels in terms of computer expertise and instructional design expertise; three self-report values: appreciation of the project approach, achievement through the project, and application of the projects. The items also include different aspects of the project experience and different barriers trainees faced during the project. The open-ended questions ask about the reasons preventing further applications and their recommendations for improvement of the approach. The complete questionnaire could be found in Apprendix.

The survey was conducted over a three-month period (February - April 2006). The researchers sent an e-mail to each participant to solicit their participation in the survey website. Quite a few participants had already changed their job and their contact information was no longer valid. Nearly 45 e-mails were returned due to invalid e-mail accounts. To ensure as large a sample as possible, participants with failed emails were then sent a letter by mail. However, still more than 20 letters were returned. Total responses were 43, representing 33% of total participants. At the end of the survey, participants were asked if they would like to participate in the interviews. Twenty-two participants chose to participate by entering their names and e-mail addresses. Upon completion of the survey, survey data were entered into SPSS software for descriptive analysis on each item and t-test on the difference between the real-job group and the hypothetical group. Open-ended questions were analyzed inductively, looking for themes within major categories.

Results

The sample population consists of 43 past trainees, representing one-third of the population across 12 fall and spring sessions from 2000 to 2005. These trainees represent more than 30 different various organizations, such as higher education institutions, government, public service (e.g. library), telecommunications industry, law agency, airlines, manufacturing, corporate consulting, independent contractor, etc. Approximately 65% (28) of survey participants come from the most recent three years. Sixty-five percent of participants chose a job-related project for their training, and 35% of participants chose to do a hypothetical project (Figure 2). The demographics of entry levels in terms of computer expertise and instructional design are shown in Figure 3. Participants rated themselves quite differently on their entry level of computer expertise (ranges from 1 to 10) and instructional design expertise (ranges from 1 to 10) on the 10-point scale. This spread-out pattern of entry levels might be an indication of diverse participants from various organizations and with different backgrounds. Trainees felt they were more skillful in technology than in instructional design. Most trainees reported a higher level expertise with computers compared to instructional design. In contrast, more than 60% of participants reported a lower level of instructional design.

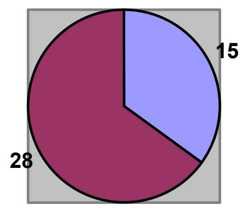

Figure 2. The choice of project

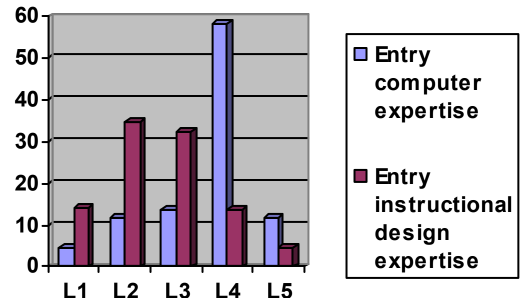

Figure 3. Participants' entry levels

The results show that the real-job project approach in the IDT context is perceived as a fairly effective training model according to the self-report values of appreciation and achievement, although the full application of their projects seems far less than ideal. Most IDT participants perceived a fairly high overall-value of the project experience (Mean=7.53, SD=1.96), and reported a fairly high achievement value by doing projects (Mean=7.09, SD=2.22) on the 10-point scale. Such perceived values were also confirmed by both novice level and experienced professionals,

> *"I feel that the IDT certificate program as a great start to my career. I has [have] only been an ID for 3 month, and this help me understand the overall concept. I appreciate the opportunity you gave us during this certification." [Novice professional]*
>
> *"I enjoyed the program immensely. Because I've been in the interactive industry so long -- 15-20 years -- much of what I learned on-the-job was not taught in formal classroom settings. It was good to learn the foundations and apply it to the details that I already knew and had been practicing for years." [Experienced professional]*

However, the application rate of their projects in the workplace is still far from the expectation (Mean=3.58, SD=3.07 on a 10 point scale). Only 3 participants in the sample population reported a full application of their projects. Nearly half the participants reported they were unable to use their projects developed in the class in their workplace at any level. While this approach allows participants to initiate responsive solutions to their job settings, both pedagogical and non-pedagogical mechanisms are needed to support a greater level of applications.

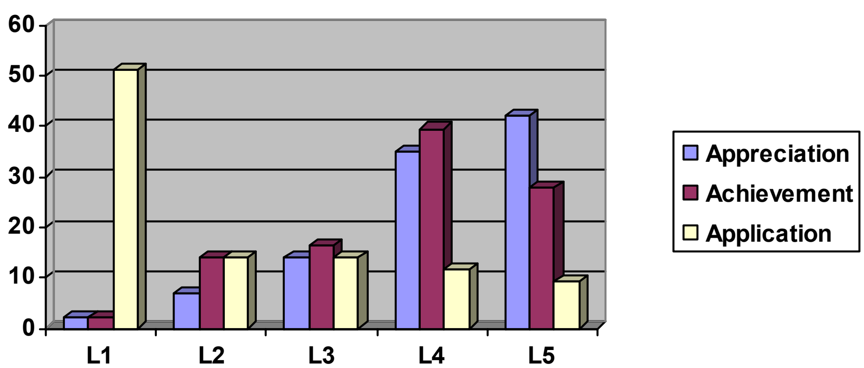

Figure 4. Self-report values on appreciation, achievement, and application.

An examination of effects along the project process also indicates perceived benefits with this approach. During their projects, participants reported a couple of favorable experience with the choice of a project (Mean=4.61, SD=.83), motivation with the project (Mean=4.30, SD=.89), enjoyment of project development (Mean=4.07, SD=1.01), knowledge integration (Mean=4.10, SD=.76) on a 5-point scale. These values have overall small standard deviation, which means people generally have same agreement with these experiences. Especially, the choice to develop a job-related project was highly appreciated; more than 75% participants unanimously viewed the choice as a positive factor in the training program. As described by one participant, "*I enjoyed the IDT session and feel that having a project of our choice to work on is extremely helpful!*" While more than 70% students reported interactions with classmates were beneficial (Mean=3.98, SD=1.17), there is no significant evidence that

interactions with their workplace colleagues were extensive (Mean=2.51, SD =1.41); half of participants reported that interactions with their colleagues either did not exist or did not contributed to their projects.

Trainees rated a little bit low on items of satisfaction with their final projects, usefulness of knowledge and skills, and impact on performance than other experience items, 3.70 (SD=1.12), 3.98 (SD=1.14), and 3.53 (SD =1.03) respectively. The standard deviation on these items also seems larger than other items, which indicates these experiences are quite case-dependent. The self-report values on different aspects of the project confirm earlier overall measurement that trainees generally valued the project approach, but perceived a little low level of application and connection between training and workplace.

In terms of barriers participants encountered, participants viewed the insufficient time as a phenomenal barrier during their projects (Mean= 2.83, SD =1.41), and followed by lack of technical support (Mean=1.86, SD=1.07), and lack of support from the workplace (Mean=1.73, SD=1.00), and a clear project idea and direction, 1.71 (SD= .97) and 1.69 (SD= .92) respectively. These barriers were also later confirmed by the open-ended questions and interview data.

Barriers during the project	**NB**	**LB**	**MB**	**HB**	**VB**	Mean	SD
Insufficient time	23.8%	23.8%	9.5%	31.0%	11.9%	*2.83*	*1.41*
Lack of technical support	47.6%	33.3%	7.1%	9.5%	2.4%	*1.86*	*1.07*
Lack of support from the workplace	53.0%	29.3%	9.8%	4.9%	2.4%	*1.73*	*1.00*
Lack of a good project idea	57.1%	21.4%	14.3%	7.1%		*1.71*	*.97*
Lack of clear directions	54.8%	28.6%	9.5%	7.1%		*1.69*	*.92*

Figure 5. Barriers with project development.

Since participants chose to do either a real-job project or a hypothetical project, further investigation was conducted. T-test was used as an analysis tool to detect the difference between those who chose to do a real job project and those who chose to do a hypothetical project. Just as expected, trainees who chose to a job-related project have a significantly higher rate of applications after the training than trainees who did a hypothetical project (t(41)=2.52, p=0.16). Although the real-job group and the hypothetical group differed in their ratings on the appreciation and achievement, both are not statistically significant, t(41)=1.50, p=.14, and t(41)=.34 p=.74 respectively. The difference on the item of appreciation seems educationally significant with one point difference on a 10-point scale.

Group	Mean			Standard deviation			N
	Apprec.	Achiev.	Applic.	Apprec.	Achiev.	Applic.	
Real-job	7.86	7.18	4.39	1.90	2.23	3.11	28
Hypothetical	6.93	6.93	2.07	1.98	2.28	2.40	15
Total	7.53	7.09	3.58	1.96	2.22	3.07	43

Figure 6. Descriptive Statistics on Means and Standard Deviations for two groups

For aspects of the project experience, two groups differed in the items of Q6a (t(18)=4.00, p=.00), Q6b (t(14)=2.29, p=.04), Q6h (t(41)=2.58, p=.01), Q6i (t(41)=2.22, p=.03), which indicates that the real-job group valued more the choice of the project, was more satisfied with their final products, and was better able to apply learned knowledge and skills. There is a small difference on all other items as well, although it is not statistically different. The evidence that the two groups differ illustrates that an authentic project raises trainees' appreciation, application, and achievement to certain levels and aspects. T-test on barrier items indicates no significant difference, which means both groups had equal need for time and scaffolding. Additionally, both groups have no statistical difference in terms of their entry levels as well, which probably indicates whether choosing a job-related or hypothetical project is not correlated to their entry levels.

According to the data, perceptions and suggestions for improvements have been categorized into five categories:

1. Build the vision for projects at an early stage. For example, program organizers and instructors need to facilitate the plan of projects, including topic initiation, project process, and its connection to the IDT job. Some specific comments include:

> *"Many people are indecisive or unaware of a good "problem" to use as a project."*
>
> *"Better balance between IDT concepts (the ADDIE model) and other factors of putting together a project - with emphasis on how to plan a project."*

"I think helping everyone understand that what they are doing in IDT is really cross functional project management and that they should have a good project management system in place before they even start needs analysis and the ADDIE process to be able to track all pieces of the project."
"Did not enough explanation of processes to do project."
"Explain the project and the goals of the project earlier on in the program so that people can start thinking about it and planning for it."
"Need much more formal sessions for the project – many hit & miss."

The strategies to build the vision include providing "more exemplary projects at the beginning" and contrast examples, "demo[nstrating] upfront of sample learning products made w/ each type of s/w," and "allow[ing] past graduates to come back for a refresher."

To help trainees make the right choice with the development tools is also important. Many participants complained of the difficulty to match the tool and project. Some typical comments include:

"Didn't know enough about the software to make an intelligent choice beforehand"
"I feel the program would be more beneficial if the students started their project the first or second week of the program. Give the students the chooses of what computer program for their project. If there is a website that they can go for trial use of each of the computer program, then they can let use know what program they want to use."
"Comparisons of common tools (Flash, Dreamweaver, Captivate, RoboHelp, etc.) used to develop instructional programs such as; skill levels, learning curves, advantages and disadvantages of each tool, integrating different tools to produce the final result, etc."

2. Define project structure and integrate formative assessment at every milestone. Besides a good vision and a right choice with tools, participants need to have a project line to flow with and check points are necessary to make sure quality of the project. The whole project could be divided into organically related sub-projects and the output of the early stage will be part of the input of the later stage.

"It seems to be a little difficult to draw connections of the content [presentations] between each. Would be helpful to have an outline or some objectives to tie everything together."
"more small, iterative steps(mini-projects) building to final project."
"I am still a little unclear of any intermediate deliverable surrounding the final project."

Meanwhile, participants need formative assessment and feedback for their intermediate deliverables. Participants felt that there was nobody to critique their assignments and, therefore, were not sure if they were on the right track.

"A CHECK Point along the way"
"More time for review with instructors. During class we were developing our project and had clear instructions with a deadline but when we came to class with our completed assignments, the instructor did not go over it with us."
"Require documentation throughout the whole process. All approved projects in a put in a pipeline and managed through the project management shop."

IDT projects in the program were actually followed with the ADDIE framework, and inter-mediate deliverables were the documentation for each stage. ADDIE deliverables were implicitly a part of instructional design but were not explicitly required and assessed for the project, which made the trainees, especially the novices, confused their project journey. Providing procedural scaffolding and giving feedback for intermediate deliverables will guarantee a more successful project.

3. Gear presentations and activities toward trainees' projects and potential applications. Professionals from business fields introduced various end products and practices, which helped trainees widen their horizons. However, from the trainees' perspective, they would like to know more about the process of design and development, rather than the end product itself. As participants commented:

"All speakers were very knowledgeable; however, they need to adjust their presentations to how each subject applies to the students and/or our jobs."
"Recommend speakers talking less about their business and more about how we can apply skills."
"Some of the business professionals focused more on their product and not how they erected the product."

Trainees also would like to have more hands on activities which are related to or inform their projects in each session.

"I would like more hands on exercise."

"As they go through the IDT program with each lecture, use part of the weekend to practice what they learned in lecture as it relates to their project(for example-project management, storyboarding)."

"As a class we needed more opportunity to participate and discuss how what we learn can be applied back on the job."

"More instruction on storyboarding."

Given the fact that many speakers presented in the training, more coordination in term of the trainees' project, rather than just the content itself, would make the projects a more collaborative effort. The individual instructor for each class could include activities and discussions responsive to the trainees' projects.

4. Overcome time constraints and provide technology scaffolding. Having insufficient time for their projects is a major challenge for participants, mostly because of the challenge to master computer tools. As participants commented,

"Not enough time learning software."

"I would have like more computer time to work on my project & get assistance before final weekend."

"Would even be willing to come an extra weekend to learn specific computer program."

"While I was lucky and had time outside of class to work on my project, I am sure that there were others whose work environments were not as flexible with their time. Therefore, perhaps a couple more hours of classroom time for project completion could be beneficial for some."

More technology scaffolding is seen as a major way to facilitate the development process.

"I felt that more lab time was needed to complete the project. It may have helped to have more training/teaching assistants in the lab while working on the projects. I had never used Flash or Dreamweaver before and I was trying to learn the software while designing a program. It was a little difficult but I managed. I would have liked more time to learn the software and more time to work on the project with more assistants in the room."

"would be to have some extra support for less self-motivated and/or technically skilled students. Learning new software and creating a project with it was a welcome challenge for me, but some individuals panic at the idea of creating a project using software that they are unfamiliar with."

However, scaffolding is not just a simply help. It needs to be a learning opportunity, and needs to be cognitive promoting and challenging. Just fixing a problem for trainees does not help their expertise in long term. As explained by one participant,

"I didn't feel that we learned Flash but that the students helping in the lab simply fixed any ""bugs"" for us."

Along with scaffolding, the time constraints could be also overcome by adjusting the lab schedule or making use of a group project. Some specific comments include:

"More time allocated, perhaps earlier in the schedule."

"Get to the lab sooner! Also, I was very impressed with how my colleagues used the software, but there was no time to get coaching from them. Some of them were much more skilled than I at figuring out what the software would do, and using it to best advantage."

"It might be good to work on a project as a group. You don't get enough technical training to really be savvy in creating slick IDT projects - - and that is what the business is looking for."

5. Explore an explicit mechanism for interactions between the training and workplace. Some participants commented on the need to strengthen the connection between training and workplace. As mentioned by a participant, "the more you can tie the class into the learner's work environment, the better." Inviting a project client from the trainee's workplace might increase involvement and interaction and, as a result, foster a more responsive project.

"I would have the participant select a sponsor at the workplace to act as a catalyst to the project during the certification and an advocate for the employee as they take on additional tasks at the workplace."

"And there is also a need to understand prioritization of projects and to communicate the prioritization process to clients to set the right expectation for delivery."

Although few participants proposed inviting a client for their project, this suggestion seems valid given the fact according to Q6d that there are only limited workplace interactions and involvements. The client could be asked to review the trainee' documents and/or sign the approval documentation. A client model paired with the real-job project approach might facilitate a deeper level application.

Conclusion

From the trainees' point of view, the real-job project approach in the IDT training is welcome because it provides "opportunities to produce end products and apply skills" and allows students to "have a goal to accomplish." Data substantiated that the trainees developed appreciation and competence through the approach, and perceived it appropriate for working adults, although the application of projects was not at ideal level. The approach does not bring in both intensive and extensive applications as expected. More detailed research revealed that the major reasons why those projects could not be applied in the workplace include the nature of the project, individual's job change, workplace constraints, pedagogical constraints, and technological constraints. While not all these issues could be addressed instructionally, the training could at least, through a design perspective, aid trainees to determine the project's direction, scope, and size, and foster more interactions between workplace and training.

Comparison between the real-job project group and the hypothetical project group favors the real-job project group in terms of appreciation, achievement, and application, and different aspects of project experience. Of course, this study employed self-report measures, so the caution is necessary because using perceived appreciation, achievement, and application has its limitations. As Thomas (1999) pointed out, self-report measures are not measures of what happened, but what participants believe happened, and thus reliance on these measures can be deceiving. Triangulation was used to overcome this limitation. Triangulation of different data, as well as performance tests, and different sessions proves the data to be representative and valid.

Caution is also necessary to generalize the group differences in this study, since the research design is not experimental. That is, real-job and hypothetical projects were not randomly assigned. Both groups were actually under the same treatment. The difference could result from other factors, such as participants' disposition, personality, etc.. However, the fact that there is no significant difference in terms of entry levels seems a favorable condition in this study. Further research is needed to compare the real-job approach and the hypothetical approach.

According to participants' open-ended questions and interviews, whether to choose a job-related project also depends on their personal status, work progress, and job background. It is unfortunate that these factors are difficult to address from an educational perspective. However, more visioning and scaffolding at an early stage could facilitate the participants to target an IDT project for the workplace. More mechanisms for interactions between the workplace and training could also keep them on job-related projects and, therefore, facilitate applications later in the workplace.

Blumenfeld et al. (1991) pointed out that project-based learning does not itself guarantee effectiveness in the K-12 context. Their view also fits in the training context. The project approach presents challenges for trainees, instructors, and institutions, and it necessitates a careful design to promote understanding, motivation, competence, and application. Five themes that require more pedagogy considerations in this study are building project vision, providing structure and formative assessment, gearing responsive sub-activities to project, overcoming time constraints because of tool learning, and facilitating interactions between training and workplace. These themes basically parallel what Barron et al. (1998) proposed as strategies in the K12 context (appropriate goals, scaffoldings, opportunities for formative assessment and revision, and social structure promoting participation). Given the context of instructional design and this real job approach, elements worth considering are IDT project vision, ADDIE documentation check points, tool scaffolding, and workplace clients. Consideration of these elements could facilitate more successful projects, more intensive and extensive applications, and deeper connections between training and workplace.

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Changing Technologies or Changing Minds: Barriers in the Implementation of Computer-Based Technologies in Turkish Schools

Diler Öner
University of Wisconsin-Madison

Abstract

The purpose of this study is to provide insight into the reform efforts in Turkey that deem integration of computers into teaching to be an essential element. While issues related to computer infrastructure and teachers' computer literacy are typically accepted as the most crucial obstacles in the implementation of computer-based technologies in Turkish schools, there may be other less visible, yet equally important, barriers. Using discourse analysis, this study identifies yet another factor that might decelerate successful computer implementation: teachers' teaching philosophies. A focus group interview with seven Turkish teachers reveals that the 'transmission model of teaching' is the main, if not the only, teaching philosophy these teachers operate under, the monopoly of which may set hurdles for both reform efforts and successful computer implementation.

Introduction and Background

In Turkey, as in most other countries, the integration of computers into the curriculum is generally associated with reforming education. Certainly, the availability of computers in schools and teachers' adequate computer literacy level are essential conditions for teachers to incorporate this technology into their teaching. Accordingly, the Turkish Ministry of National Education (MNE) has invested significant amount of money in computers for public schools since 1984. These efforts gained a new momentum especially in the last 15 years. In order to provide models of computer use in a reformed educational system, new types of schools that were equipped with computers and new curriculum agendas were established, and teachers have been provided computer training to increase their competency with computers. While these improvements are necessary conditions to integrate computers into teaching, the low level of computer utilization of seven Turkish teachers in their teaching in a context where computers are available and these teachers consider themselves as competent computer users suggest the presence of other barriers. In this study, I explore one of these less visible barriers that is evident in the way teachers talk about their teaching with computers. My study shows that these teachers mainly operate under a 'transmission model of teaching,' the primacy of which may get in the way of reform and successful computer implementation. By identifying such a factor, I aim to draw attention to its implications not only for teacher education and teacher professional development programs, but also for the larger context of the educational system.

Having realized that it had an insufficient computer-literate work force for the foundations of an information-based economy (Yedekcioglu, 1996, January), Turkey started to invest in computers in schools in 1984 (Odabasi, 1998). In the following years, this enterprise has gradually coupled with reform ideas. In especially two prominent reform projects, it is apparent that computers have been considered as an essential input of the educational reform movement in Turkey.

Milli Eğitimi Geliştirme Projesi (MEGP) (the Project for Improving National Education) is one of these projects that was initiated by MNE in 1990 in order to keep up with the change and development in contemporary education. [1] Two categories of schools have been determined as the practice areas of this project: Curricula Laboratory Schools and Computer Experimental Schools. These two types of schools have been the sites for pilot studies for the programs or projects developed by the Department of Education Research and Development (EARGED). These schools are equipped with the relevant instructional materials, the priority being computers and educational software, in order to apply those programs. Later, MNE started the Temel Eğitim Projesi (TEP) (Basic Education Project) in 1998. This project has had three-fold goals: improving 1) physical infrastructure (e.g., construction of new school buildings or restoration of available school buildings), 2)

[1] This project is completed in 1999 (MEB, 2005).

educational quality (e.g., building computer labs), and 3) quality of teachers (e.g., teacher professional development for computer literacy) (MEB, 2005). [2]

In both projects, one of the main goals has been to disseminate and establish computer aided education along with improving physical infrastructure of schooling. More importantly, both projects aimed the use of computers to stimulate reforming Turkish education. As one can see in the Basic Education Project, computer integration related goals are considered as a quality rather than a physical infrastructure issue. Furthermore, being able to use computers is considered as an essential characteristic of the ideal student these projects aim to cultivate. In Curricula Laboratory School model, an ideal student:

> [H]as scientific and rational thinking skills; is analytical and inquiring; is one who does not memorize facts [or knowledge] but one who can access it, use such knowledge, and able to share it; has communicative skills; *is an effective user of technology* [emphasis added]; fulfills one self and also possesses common shared human values; is creative, productive, cooperative; is one who knows how to learn and values life-long learning skills (EARGED, 2006, Ogrenci Merkezli Egitim, para. 1).

Efforts aimed to solve infrastructure issues gained a new momentum in 2003. The government initiated the campaign ‘100% Support for Education’ in September 2003 that allowed tax-free donations for the national education. In this project, schools report their needs through the project website and philanthropists may aid a school according to these needs. It appeared that computer-related needs constituted the most significant portion of these reports and funds have been allocated toward this direction. While at the end of the 1998, there was one computer available for three schools (Ozden & Cagiltay, 2000), with this campaign, the ratio became one computer for 55 students. In the near future, as the campaign continues, it is expected that the ratio will be one computer for 35-40 students (Egitimde teknoloji devrimi, Aralik 2005 - Ocak-Subat 2006).

Infrastructure related initiatives were also joined with support for teachers in these technologically-enriched educational environments. One of the support attempts for teachers who work in either Curricula Laboratory Schools or Computer Experimental Schools has been continuous teacher in-service computer training. In 1996, Yedekcioglu (1996, January) reported that approximately 100,000 teachers have taken in-service computer training. More recently, MNE collaborated first with Intel in 2003 and later with Microsoft in 2005 in order to initiate teacher professional developments that were aimed to make teachers computer literate. To date approximately 80,000 teachers (about 13 % of the whole teacher population) received their certificates from these programs (Egitimde teknoloji devrimi, Aralik 2005 - Ocak-Subat 2006).

The assumption underlying all these efforts has been that if schools are equipped with computers and teachers can become competent users, then computers will be used in education to realize the ideas of reform. This idea finds support from the literature on two levels. First, according to Stevens (1982) two main factors determine successful implementation of computers: teachers’ attitudes toward computers and their levels of expertise with computers. Studies have also shown the correlation between the two; that is, teachers develop positive attitudes toward computers as their competency level with computers increases (Madsen & Sebastiani, 1987; Yildirim, 2000). Secondly, research suggests that the use of computers in classroom can promote the ideas of reform, such as student-centered instruction. In one of the most comprehensive longitudinal study of technology-using teachers program, namely Apple Classrooms of Tomorrow, Dwyer, Ringstaff, and Sandoltz (1991) found that changes brought by teaching with technology caused teachers to interrogate their beliefs about learning and efficacy of their instructional activities. The teachers in this study shifted from curriculum-centered towards student-centered instruction, from individual towards collaborative tasks, and from passive towards active learning (as cited in Topper, 1998).

Given all these investments, the vision, and promises of using computers in education, it becomes even more important to recognize the obstacles that might decelerate successful computer implementation. Although infrastructure and computer competence are important factors for integrating computers into teaching, they may not assure that the intended goals of reform will be achieved. This study tries to bring light to one of the less mentioned and less visible barriers in the implementation of reform with computers in Turkish schools. By employing discourse analysis as the method, I examine how teachers talk about computers as an instructional

[2] The first phase of this project completed in 2003 and the second phase was initiated in 2002 (MEB, 2005).

tool. By doing that I aim to reveal the underlying teaching philosophies teachers hold. I argue that teachers hold a 'transmission model of teaching' and, coupled with their teacher-centered teaching practices, this view gets in the way of realizing the potential of computers for different teaching practices. For computers to play a crucial role in the reform movement, the monopoly of these practices and philosophies should change while changing technologies in Turkish schools.

Below I draw from Case (1996) and Sfard (1998) to discuss different learning theories that are founded on different philosophical assumptions. I define the 'transmission model of teaching' based on the behaviorist learning theory, which is derived from British empiricism (Case, 1996) and rooted in objectivism (Jonassen, 1991). Next, I use Case's and Sfard's ideas to present alternative paradigms for knowledge and learning, which point the way to alternative pedagogies. Following Sfard and Boaler (2002), I emphasize that none of these views are superior to each other. Rather, it is the diversity of different views of knowledge from which any education reform can benefit.

Philosophical Foundations of Learning Theories

The roots of the first view of knowledge that gave rise to the didactic theories of learning lie in British empiricism (Case, 1996). In the field of education, the major and most influential theory that originates from empiricist philosophy has come to be known as behaviorism. Behaviorists define learning as the observable change in behavior, excluding the role of mind in learning from their analyses. Mind is viewed as a 'tabula rasa,' an empty vessel, waiting to be filled with the knowledge of the natural world. In behavioral (and most of cognitive) psychology, such knowledge is considered to be objective – out there – and transmittable (Jonassen, 1991). Jonassen describes the assumptions of an objectivist approach to learning:

> Objectivism—the more common scientific conception of reality—holds that there is an objective reality that we as learners assimilate. The role of the education is to help students learn about the real world. Students are not encouraged to make their own interpretations of what they perceive; it is the role of the teacher or the instruction to interpret events for them. Learners are told about the world and are expected to replicate its content and structure in their thinking (p. 10).

Thus behaviorist pedagogy typically regards learners as the passive recipients and underlines an instructional approach that focuses on the quality of the "transmission of knowledge" (Jonassen, 1991). From now on, I will refer such philosophy of teaching founded on behaviorism and objectivism simply as the 'transmission model of teaching.'

Although behaviorist epistemology has been the dominant paradigm for the conceptions of learning for most of the first half of the 19th century (Jonassen, 1991), empiricist and objectivist traditions have not had the sole impact on conceptions of knowledge, learning, and pedagogy. Rationalist and sociohistoric stances provided alternative and foundationally different directions in education (Case, 1996). In fact, much of educational reform has been advocated through these two paradigms.

The rationalist view gave rise to the well known constructivist learning theory that has mainly originated from the work of Jean Piaget. Piaget's theory states that mind applies existing knowledge structures to the new experience, and learners engage in an active process of making sense of the environment, and this process in turn determines the rate of cognitive development. Although constructivist learning theory evolved into different forms in time, such as radical constructivism and social constructivism (Ernest, 1994), its basic pedagogical implications remained with us: rather than treating the child as an absorber of transmittable knowledge, teachers should actively engage youngsters to build their own intellectual structures. Thus, while behaviorist pedagogical model emphasizes the one-way transmission of concepts from teacher to the students, constructivism is based on the belief that knowledge emerges from interaction.

For the last two decades, however, educational research has been influenced by another paradigm shift. While Case (1996) names the new perspective sociohistoric, Sfard (1998) examines the resulting change in learning theories in terms of metaphors. In recent publications, Sfard detects the emergence of a new metaphor of learning, namely the *participation metaphor* (PM), which underlines a different view of knowing. This view

lies in contrast to the *acquisition metaphor* (AM) that regards knowledge as substance, and learning as the acquisition or construction of that knowledge. Thus, Sfard considers both the behaviorist and constructivist theories of learning under AM. PM, on the other hand, views knowledge as the aspect of practice/discourse/activity, and learning as becoming a participant in a social context. Theories of situated cognition that put an emphasis on learning as a legitimate peripheral participation (Lave & Wenger, 1991) are characterized under PM. Sfard holds that in PM "the permanence of *having* [emphasis in original] gives way to the constant flux of *doing* [emphasis in original]" (p. 6). Learners are characterized as being interested in participating in certain kinds of activities rather than being in the position to accumulate private possessions.

However, it would be too simplistic to decry AM over PM, as Sfard (1998) wisely reminds us. These two perspectives perhaps complement each other in a way analogous to the 'light' phenomena in physics and illuminate and guide classroom practices in appropriate moments (D. W. Shaffer, personal communication, April 2004). Moreover, the dominance of a single theory in educational research and practice has been criticized on the grounds that it inevitably narrows our thinking and limits progress in any educational innovation (Boaler, 2002). Thus, it is the multiplicity of different views of knowledge from which any educational innovation can benefit. In fact, in the U.S., we see that the ideas of mathematics education reform promoted by the National Council of Teachers of Mathematics ([NCTM], 2000) are consistent with more than one approach, both constructivism and the psychological theory of situated cognition (Senk & Thompson, 2003).

Methodological Framework: Discourse Analysis

The methodological tool employed in this study is discourse analysis as conceptualized by Gee (1999). As discourse analysis is the analysis of language in context, the tools of inquiry it provides help to illuminate the aspects of the context where the conversation takes place. Gee argues that language has a magical property of both reflecting and shaping the context. From that perspective, meaning is always a function of 'now' and 'before.' Gee defines two interconnected primary tools of inquiry for a discourse analysis that address now and before: 'situated meanings' and 'cultural models.' A cultural model is what we bring to the situation, our taken for granted assumptions about what are normal or typical in order to both function and understand the context where meaning is situated. A situated meaning, on the other hand, is what something means at that particular context connected to the cultural models it is attached to. This mutual way of reflecting and constructing the social world in turn gives meaning to the situated identities the participants enact and situated activities they are involved in a particular context. Gee defines the language (social language) used to construct these situated identities and situated activities as *discourse*. He further argues that it is not simply the language that is important. We also use certain ways of speaking, being, acting, thinking, valuing, believing, knowing, and so forth. to be recognized by others as particular 'who's' engaged in particular types of activities. Thus the 'big D' *Discourse* comprises both language and non-language 'stuff' that we use to display and recognize specific situated identities and activities.

Based on this framework, I consider teachers' theories about teaching or what they take for granted as the role of the teacher as a 'cultural model' that reveals itself in the way they talk about computer use in their teaching. This framework also enables me to pay attention to the context of data collection in which I and my participants enact situated identities within a situated activity.

Method

The data that I analyze in this paper is a focus group interview that I conducted with seven Turkish teachers. These teachers work at the same inner city Ilkogretim School, which is located in an affluent neighborhood of Istanbul, Turkey. An Ilkogretim school is the combination of five-year elementary and three-year middle school, which has become compulsory since 1997. This school is a Curricula Laboratory School; that is, the school is equipped with a computer lab and educational software, and these teachers have had several in-service computer training courses. They also define themselves as "experienced" in their computer competence. Of the seven teachers, three of them are elementary school teachers, two are mathematics teachers, one is a computer teacher, and one is an English teacher. The average teacher age in the group is about 42 with an average of 22 years of experience.

During the interview, I asked three main questions: 1) how do you evaluate your teaching with computers? 2) what do the individuals or groups of individuals, who are important for you or whose opinions

you value, think about your use of computer-related technology in your classroom? and 3) considering the factors or circumstances that may facilitate or impede your teaching with computers, how much control do you believe you have over using computers in your classroom? The interview was audio-taped and transcribed. I translated the quotes from Turkish to English.

Instead of numbering every sentence, I gave each turn a person takes a line number in order to keep the meaning in context. The smallest object of analysis is these individual turns that teachers take during the conversation. Most of the time teachers addressed or responded to one single issue when they took a turn. For this reason, I will call these turns "stanzas," since they can be regarded as devoted to a single topic (Gee, 1999). Also when I give parts from the transcript, I first write the line number of the stanza and then speakers' initials. I underlined the words that are stressed. I excluded some irrelevant sentences and used bracketed ellipses to indicate that. Ellipses at the end of the sentence shows that the sentence is not finished. The statements in brackets are either my or other teachers' comments or reactions to what has been said, or the possible words or phrases that I think the speaker intended to say. The stanzas in italics are my own.

In analyzing data I first categorized the whole interview into themes/motifs, the parts of interview that correlate with each other. In this way, one can set the analysis in the larger context of the whole interview (Gee, 1999). Then I used these to form a hypothesis about some of the cultural models. Gee says one way to get at people's cultural models is to ask "what I must assume this person (consciously or unconsciously) believes in order to make deep sense of what they are saying." After stating my hypothesis that I have drawn from the overall interview, I present the evidence for this from the parts of the interview where teachers have talked about the way they employ computers in their classes. Then I look for *coverage* and *convergence* (Gee, 1999), that is, whether the hypothesis I have generated illuminated other parts of the interview and whether the ideas from the other parts continued to support it. My analysis has also included the activity and identity building of my self as well as that of the teachers to sustain my argument.

Results

Looking at the whole interview, I identified three main issues teachers addressed, which are relevant for the present analysis: 1) their evaluation of the use of computers in education (regardless of whether they use them in the classroom or not), 2) factors that impede or help their teaching with computers, and 3) the way they employ computers in their classes or the way they think they could use them. Then I identified themes/motifs within these interview sections. In this way, I partitioned the interview into underlying ideas, and this helped me to form a hypothesis about the cultural models of teaching. I provided parts of the discussion when relevant for the themes. These themes and my organization of the interview into different topics are not necessarily mutually exclusive. Sometimes two or more themes can be found in a thread of discussion or some sections of the interview may speak to more than one issue I outlined above. Below I start exploring these themes both to provide the background and to build a hypothesis. Then I analyze sections of the interview to provide evidence for the hypothesis.

1. Teachers' Evaluation of the Use of Computers in Education

Theme: Positive attitudes toward teaching with computers. All seven teachers, except one who is self-taught, learned to use computers in in-service computer trainings, and regarded themselves 'experienced' with computers. However, of seven teachers in this group two of them never taught with computers. And the others also reported that they are not using computers at a desired level because of the factors impeding their use of computers in class. In evaluating the use of computers in education, however, nearly all the teachers expressed positive attitudes towards using computers in education and in their classes. The majority of them said computers were very beneficial in education.

Among the benefits of computers teachers mentioned, visual aspect, novelty effect, and saving time were the main ones. Teachers mentioned that computers can afford learning by experience and, given that students are fond of technology they would be more motivated to learn with computers. In addition, computers can help teachers to save time, since once they prepare their classes with computers, they would not need to write things down on the blackboard. One teacher said:

41. SI: If I used it how would I evaluate it? [repeating the question being asked] At least the kid by seeing, I draw these [the pictures] on the board, I draw the pictures on the board. It is a waste of time. But [if] I have the computer in front of me […] if we show them [pictures] on the screen using the projector, then kids have fun while learning, I mean they learn by implementation. First of all we save time, we hit the button, and students see the picture right away and I just explain it. If students at least learn by seeing, hearing, experiencing…
42. DO: Again you think it is entertaining.
43. SI: Absolutely, absolutely.

Theme: Hesitation and uncertainty about the real value of computers in education. Despite their positive attitudes toward teaching computers and locating computers' benefits in teaching, two of the teachers first hesitated to make evaluations about teaching with computers. However, these statements were not completely opposing their positive evaluations, rather they were additional. One of the teachers said:

24. AA: Since we do not teach with computers, to say something about it, [I: I hear you] it is kind of awkward [another teacher: yeah it is]. But I personally would like to teach with computers, I would want that, though I am not quite sure about what the actual result would be [I: mm hm]. I prepare my exam questions and the answer key on the computer, and I like that. But I do not know what the result would be [if I teach with computers].
25. DO: But what do you think about teaching with computers?
26. AA: I say it is good [I: good], very good [I: very good]. It would be very beneficial, I think [I: you say beneficial] yes.

The other teacher also expressed uncertainty about the real value of computers in education. This teacher made clear that she was uncertain about what computers can offer instructionally, which was due to her lack of teaching experience with computers (which was due to the impeding factors to teach with computers). She said:

47. GA: Let me put it this way, science classes, especially science classes, umm… should remove blackboard and chalk. And as my friend articulated [learning] by doing and experiencing…
48. DO: Do you think computers can provide that?
49. GA: The computer… that's I don't know yet. Also the student… it [education] should be student centered, and the student should be questioning, thinking, and interpreting. However, I do not know yet if this can be done with computers, yes. Yes, it is good in terms of time management, and I agree with my friends with that […] [but] there is only one small screen in our classes. Screen…I mean the most…

One other teacher, DG, also revealed some concerns. What was underlying his statements was the idea that computers might threaten teachers' position as the center of knowledge. Below is the part of the interview he expressed these concerns.

93. AA: (To DG) […] could you tell me that 'you my fellow teacher [hocam] if you do your math class with computers it would be better than the current situation?' […] your advice for me, 'you my fellow teacher, if you teach like this with computers, by using this technology, you would teach more productively, more effectively, more productively?'
94. DG: There is this thing, you sit at your table and there is a big screen, and students look at that. "Okay children look at this now, here is the formula for that, here is the example," and some things are going on on the screen. There is no such thing. If there were then why would you need a teacher? The teacher should own the knowledge at the end. The human factor should be available there. There are great computer programs. By just spending three hours on the computer daily, you can have two university diplomas. But the human factor here is important.
95. AA: But that preparation is yours, you make that, you show it to students and then explain it on the blackboard.

96. DG: But we should be thinking about <u>this</u>, okay we use computers, for instance <u>what</u> am I going to show to students on the computer and <u>what</u> not to [AA: of course] I do not think that blackboard and chalk is that bad, I am telling you.

2. Factors that Help or Impede Teachers' Teaching with Computers

Upon being asked, teachers briefly mentioned factors that had been helpful for them to teach with computers. These were mainly teacher professional development trainings, parents' and students' expectations, and support from previous school principles. However, the majority of the time, they talked about factors that impede their teaching with computers, and they ascribed their low level of computer use to these factors. Two main themes emerged in this dimension.

Theme: External obstacles. Teachers mentioned factors such as lack of infrastructure and lack of continuous support for the available infrastructure, lack of time to prepare and use computers in the class, lack of software, and lack of support from the school administration as obstacles to teach with computers. I categorized these factors as micro-level constraints as they relate to local structures. In addition, teachers pointed out the general problems of educational system in Turkey, such as, the system's general emphasis on memorization of facts, low share of educational expenditures from the budget, low investment in computers, and finally corruption. These factors are categorized as macro-level constraints as they imply larger scale perceived obstacles. All together I considered these two types of factors as external factors, factors teachers think they have little control over.

Theme: Internal obstacles. However, teachers also made statements that revealed their lack of interest and motivation for using computers. One teacher said: *"But to me with what we are provided so far, something could have been done if [we] wanted. But…There is knowledge but…"* I considered these types of obstacles as internal, given that these were the types of obstacles teachers associated with themselves at the personal level. However, mention of internal obstacles was a lot less than the external ones.

3. The Way Teachers Employ Computers in their Classes or the Way They Think They Could Use Them

Theme: I [could] use computers to present the topic or after the topic is presented. The interview data also speak to teachers' current practices with computers or how they could use them potentially. Here the use of computers to present the topic or after the topic is presented appeared as an underlying dominant theme. Teachers make use of computers (or they think they could use them) as the containers of their lectures or as the container of practice problems (as available in educational CD's). Here we see that the main benefits of using computers are to save time in order to do more exercise problems, to motivate kids, and to get feedback. Below are two threads of discussion where this theme is evident.

75. AA: […] I am saying that if I prepared my lesson on the <u>computer</u>, on a diskette, did my practice and present the topic with the <u>computer,</u> I would be <u>more</u> effective, give <u>more</u> knowledge, and save more time.
76. GA: By all means, we believe that.
77. LK: There would be more time to do more exercise problems.
78. AA: I would do more practice problems and make students comprehend the <u>topic</u> better.
79. SI: And also [kids] learn by seeing. [Kids] find it more entertaining.
80. AA: In short, if I teach <u>with computers</u>, the situation would be <u>better</u> than the blackboard and chalk environment.
81. RA: [it] removes [blackboard] yes.
82. LK: Also there might be things even we forget [to mention], we are also human. There [in computer] one can go back, immediately realize, realize things that we skipped.
……………………..
56. DO: What do you think Mrs. … [to LK]? Do you think it is <u>beneficial to you</u> in your classes?
57. LK: It would be beneficial, <u>but</u> if we were connected to the Internet. Then more…
58. DO: I guess you have a computer lab with the Internet connection downstairs.
59. LK: Yes but the lab had not been open [GA: the classrooms do not have it (the Internet)]. Last year its door was closed [locked].

60. DG: The lab has the Internet [connection] but not the classrooms.
61. LK: Not in classes. The lab was not open to us either. And for that <u>we</u> could not utilize it. But I make use of CD's. I insert the CD and, there with students, well in math there are practice problems usually. After the topic is presented, we enter those practice problems.

Similarly, below SI suggests that the computer could make it a lot easier to provide practice situations for her students. This conversation takes place in the context where DG explains his concerns about computers, which I quoted earlier.

94. DG: There is this thing, you sit at your table and there is a big screen, and students look at that. "Okay children look at this now, here is the formula for that, here is the example," and some things are going on on the screen. <u>There is no such thing.</u> If there were then why would you need a teacher? The teacher should own the knowledge at the end. The human factor should be available there. There are great computer programs. By just spending three hours on the computer daily, you can have two university diplomas. But the <u>human</u> factor here is important.
95. AA: But that preparation is yours, you make that, you show it to students and <u>then explain it</u> on the blackboard.
96. DG: But we should be thinking about <u>this</u>, okay we use computers, for instance <u>what</u> am I going to show to students on the computer and <u>what</u> not to [AA: of course] I do not think that blackboard and chalk is that bad, I am telling you.
97. *DO: Blackboard and chalk are also technologies.*
98. GA: Well I say that <u>for instance</u> for science classes.
99. SI: See, it is different for English. I prepare the picture and project it to the wall. But I draw the picture or by finding it somewhere [LK: you cut it, paste it] I cut it, paste it. This takes my time [...] But if the picture [slide] is on the board, okay I sit down, I ask kids and we talk about it. We finish with one [picture], and then we start talking about the other. You see what I mean? This all happens with <u>one button</u>.
....
101. SI: <u>Of course,</u> I give children the structure first. I give [present] the topic, they all got it, we did the grammar, when we <u>turn practicing</u> we will articulate it [the topic?] with the pictures. <u>Then</u> I need it [the computer] with the projector.

Hypothesis

Based on the overall interview data, I form the hypothesis that teachers hold a transmission model of teaching and regard the computer within that philosophy. They view knowledge as something that can be assimilated and further regard themselves as the dispensers of that knowledge. Within such philosophy, computers are mainly perceived as efficiency devices, that is, helping teachers to save time in presenting the topic and in doing the practice problems.

Computers in Action: Two Cultural Models at Play

1. Computers in real life, computers in education. If we look at teachers' statements regarding the use of computers in education, we see that they bring up the theme of 'efficiency' such as 'saving time, making instruction easier, etc.' as the central benefits of using computers in the classroom. This suggests that these teachers relate the 'technology in the classroom' directly to the 'technology in real life.' In other words, they transform the cultural model they hold about technology in general to the classroom setting and try to make sense of it within their current classroom practices. The following quote captures this idea.

28. RO: Use of computers in education, enables us to reach our educational goals <u>faster</u>. I mean… well, umm technological developments that make our life easier will also make <u>education</u> easier, I mean, make easier to <u>educate</u> students, make instruction quicker, and will <u>enable</u> to teach <u>more effectively</u>.
[...]

2. *Transmission model of teaching.* However, the data also suggest that seeing the computer as an efficiency tool is not only due to teachers' overlapping cultural models; it is also influenced by their underlying conceptions of knowledge and learning.

Let us consider stanza 41, which is quoted above. Here SI talks about using the computer to show students pictures, which she uses to have students to use their English in explaining them. She invokes the ideas of novelty effect and "leaning by implementation." She refers to "learning by implementation" showing students the pictures on the computer, which underlines a view of learners as passive receivers. It is reasonable to argue that "learning by implementation" would mean quite different things to someone who conceptualizes learning as a process of active construction or participation within a community of learners. Since students like technology (a comment she made earlier), she assumes that they will be engaged in whatever practices they are involved with. In the conversation that starts with stanza 94 (owned by DG and ends with her stanza 101), we see that DG puts forward the idea that *"the teacher should own the knowledge at the end"* and AA trying to build an argument that computers are not that threatening as long as "the preparation" is owned by the teacher. SI aligns herself with this uncontested idea (along with GA) by first clarifying the computer use as a tool that makes her classroom practices efficient. That is, computers are not that bad as they make the use of pictures easy. Then she clearly states that: *"Of course, I give children the structure first. I give [present] the topic"* and reveals a cultural model of teaching that underlines herself being the container and dispenser of knowledge.

GA is actually the only teacher who articulates explicitly concerns about the compatibility of computer use with the student-centered educational philosophy (see stanzas 47 and 49). She accepts that using computers can help saving time; however she is not sure how they can be used in a student-centered way. Nonetheless, one cannot conclude that she is actually holding a student-centered perspective. In stanza 98, she finds a way to agree with DG. She says *"Well, I say that for instance for science classes,"* by finding the middle way with her statements before and with DG, who basically favors blackboard and chalk over computers, since blackboard and chalk help to maintain the teacher's status as the center of knowledge.

LK talks about using educational CD's "after the topic is presented" (see stanza 61). Although she uses a passive structure there, and it may seem as we may not be sure who presents the topic—the teacher or the students, but the word that she uses for "presenting" in Turkish is more similar to "lecturing," which is mostly attributed to teachers. She mentions the Internet; however she does not make any comments either here or in the rest of the interview for how she might utilize it. Her current teaching practices, as explained here, also do not seem to indicate the use of computers to engage students in any kind of exploration that could lead to construction of knowledge or participation.

In stanza 75, we can see that AA clearly articulates a position as the center of knowledge and only sees computer as a supporting tool for his effectiveness: *"[If I used computers] I would be more effective,* ***give more knowledge*** *[emphasis added], and save more time."* And we see GA also agrees with that statement, even though earlier she conveyed her concerns about the usefulness of computers in a student-centered classroom. AA further associates making students comprehend the topic better with doing more exercise problems in stanza 78. And for SI since technology is inherently interesting for students, she aligns her line of thought to this tread too. AA finally concludes that if he teaches with computers, "the situation would be better than the blackboard and chalk classroom." However, the transition from blackboard to computers can be a better one not because it might help to change the traditional role of the teacher as the owner and dispenser of the knowledge; it is a better one since it is more efficient in sustaining this positioning of teachers'.

This position is most clearly articulated by DG (stanza 94) with the sentence "The teacher should own the knowledge at the end." As evident in his stanza 96, DG also views the computer as threatening the information center position of the teacher and favors the older technology (blackboard) as a way to maintain that status. He says *"But we should be thinking about this, okay we use computers, for instance what am I going to show students on the computer and what not to."* These statements suggest that DG fails to realize other possible forms of couplings with computers and his teaching.

Coverage and Convergence

This hypothesis can also help us understand the other parts of the interview (coverage) and other parts continue to support the hypothesis as well (convergence). As stated earlier, these teachers reported that they were not incorporating computers in their classes much, although all of them consider themselves computer-literate. In addition, they articulated very favorable attitudes toward teaching with computers. Eventually, one

would expect that these teachers do teach with computers all the time. However, they do not. Later in the interview, they mention several micro-level and macro-level factors affecting their control over the use of computers in their classes. And they claim that it is these factors that are holding them back. However, I argue that the reason teachers do not incorporate computers in their teaching can still be explained by the hypothesis that teachers hold a view of knowledge as something that can be contained and transmitted, and a view of themselves as the center of knowledge.

Fey (1989) describes several roles that teachers can enact in a technology-intensive learning environment. When technology is available, we might see shifting roles for the teacher from expositor and drillmaster to task setter, counselor, information resource, manager, explainer, and fellow student. It seems that the reason why these teachers have difficulty in seeing the role of the teacher as anything other than the information dispenser may be due to their cultural model of knowledge. For them knowledge is something contained in some kind of storage (either in them or in the computer) and this creates the tension of 'either or,' which in turn blocks them from benefiting from computers in ways other than presenting information.

Moreover, their claim that infrastructure is the biggest issue that restrain their using computers in their teaching becomes weaker since in another part of the interview they displayed a lack of awareness about the technical means available in the school, which was evident in the following excerpt:

> *249. DO: [As] we talked about it earlier, we talked for the 4th question, <u>everybody</u> wants it [use the computer], finds it beneficial for student learning, and there are computers in your school as well.*
> 250. AA and some other teachers: Yes that is our common view, we all want it.
> 251. LK and ZK: But, <u>having access</u> to the Internet… It is <u>not open</u> to <u>every</u> teacher, isn't it? Is it open to every student or teacher? No.
> 252. The computer teacher: It is [open to everyone] actually. And every computer in that room has an Internet connection.

It is true that teachers' indifference regarding the technical resources and means available at the school can be partly explained by the lack of technical support they receive. They might think that they would have to waste time to troubleshoot technical problems that would be either caused by low competence on computers or by insufficient technical equipment. But an alternative explanation appears to be that what teachers really think might be the irrelevance and/or inconvenience of computer implementation with their classroom practices or with their educational philosophy. Viewing computers merely as presentation devices, they may think that computers are not essential for their teaching style, since presenting the topic is something they attribute to themselves as teachers and they do not necessarily need the computer for this.

Activity and Identity Building. Then why do these teachers choose to speak about computers this way? In order to answer this question, I need to address the kind of activity they and I were building, and kinds of situated identities they and I were enacting. As a person whose parents are either teachers or school administrators, I have spent a lot of time with similar group of teachers and engaged in similar conversations in non-formal settings in several times. In such situations, teachers do not necessarily enact their professional teacher identity. However, these teachers only knew me as a graduate student who was interested in computer use in their schools. I had a permission letter from the Ministry of National Education to do research in their school and we were involved in a school-based activity together. In order for me to recognize them as teachers, they needed to situate themselves in the teacher [capital D] *Discourse* (Gee, 1999), and use the related social language. During the interview they were enacting their professional identity as teachers by using the words of the teacher discourse, such as, *educational goals, interaction with students, gap between students, low-level versus high level students, participation in class, visual, auditory methods*, etc. In addition, they were most likely saying things that I would like to hear from them, such as *"learning with experience, interaction, etc."* While interacting with me, they were employing the social language of teaching and constructing their identities as professional teachers.

Teachers' activity and identity building did not happen in a vacuum. I also participated in it, and the reader can recognize my identity construction as a researcher in this interview. I was acting on my researcher identity by stopping them whenever I felt they said things that I thought would not be relevant for my research questions and also providing them the vocabulary to talk about their experience, such as "motivating, entertaining, or beneficial." Ultimately, my identity and activity building were interacting with those of the

teachers', and mutually forming each other. Thus, teachers' positive evaluation statements about teaching with computers need to find meaning within this joint activity and situated identity building.

In summary, the main reason of not using computers in teaching is not related to merely infrastructure-related problems. Teachers' positive evaluations are mostly due to the joint activity and identity building rather than being an indicator of what they really think about computers. Seen from this perspective, these positive statements about computers fail to imply an alternative explanation (That is, these teachers like computers, and they want to teach with computers, but infrastructure problems are restraining them). Therefore the discrepancy between these positive evaluations about teaching with computers and teachers' actual classroom practices is mostly understandable on the basis of the hypothesis generated (coverage). In addition, other parts of the interview also continue to support the hypothesis (convergence) by refuting this alternative. More specifically, the hypothesis is also being supported by the fact that the teachers appear to be indifferent to the technological resources available at the school.

Discussion

In the educational realm, it is important to know about factors that could block or decelerate reform efforts. This becomes even more important in a context where a lot of funds have been allocated for reform. Burbules and Callister (2000) argue that reform will not simply follow from changing technologies in schools, since this is only a small part of educational reform. Along with technology, other educational practices and relations need to be changed for computers to play the desired role within reform efforts. The findings of this study corroborate this idea by identifying a less visible factor that functions as an obstacle to use computers in education and to realize the ideas of reform. The data suggest that teaching philosophies of the seven Turkish teachers operate as such a barrier. It is not, however, the purpose of this paper to criticize these teachers' heavily behaviorist foundations in teaching, even though more recent educational reforms have advocated abandonment of behaviorist philosophies. Rather, following Sfard (1998) and Boaler (2002), what I want to emphasize is the dominance, if not the singleness, of this view that may be blocking reform efforts.

The findings of this study are important as this study takes the discussion about reform obstacles to a new ground. Apart from issues related to technical access to computers and computer literacy, it is suggested that teachers need to become aware of and reflect on their teaching philosophies, a process which will help them to take different roles in technology-rich environments. With their current cultural model, teachers view computers only as efficiency devices, which help them to save time in presenting topics and in doing practice problems. If teachers, however, operated under alternative views on knowledge and learning, they would more likely design activities with computers differently. For instance, if teachers also viewed knowledge as the aspect of practice/discourse/activity, and learning as becoming a participant in a social context, they could move from being the center and dispenser of knowledge to acting more like a facilitator. Teachers would concentrate on designing meaningful activities in which students want to participate and computers can be used as tools to solve more authentic and challenging problems.

One implication of the findings of this study is that both teacher education and teacher professional development programs need to address issues larger than computer literacy. While the administrative system constantly assures solving financial and technical level problems, teacher education programs and teacher professional development need to offer alternative models of knowledge and learning. This could help teachers to realize the potentials of the computer other than just being a presentation device, as the prevailing monopoly of the transmission model of teaching may hinder teachers to implement new technologies in a way envisioned by any reform ideas.

Although the purpose of this study, by its nature, is not to make generalizations, I believe the findings are not unique to the Turkish context. We know that in almost every country, teachers do not embrace new technologies for instruction easily. [3] This study highlights the availability of less detectable yet significant factors that may help us understand why teachers in general are not adapting technology at desired levels.

In addition to the findings, I would like to highlight the notion of 'cultural model' (Gee, 1999) as a powerful theoretical construct, as an alternative to the most common notion of 'belief.' What leverage does one gain by calling teaching philosophies as *cultural models* rather than as *beliefs*? First, by identifying something

[3] Cuban (1986) documents several reasons for the U.S. situation.

as a cultural model, one is empowered with a complete theory about human sense making that reveals itself in the way we speak and orient ourselves to language. This theory informs us that we are usually unaware that we are operating under certain cultural models and their full implications. And unless they are challenged by someone or by new experience where our cultural models do not fit, we keep functioning under them. Second, a cultural model is distributed; bits and pieces of a cultural model are in people's head, and other bits and pieces reside in the practices and settings of cultural groups. That is, this conceptualization highlights the role of a larger social context in the formation and sustaining the cultural models one has. Thus, while the notion of belief comes with a connotation of something personal and internal, the idea of cultural model draws attention to a larger social context, leaving one to question perhaps the whole educational culture.

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Student Strategies for Succeeding in PBL Environments: Experiences and perceptions of low self-regulating students

Anne Ottenbreit-Leftwich
Peggy A. Ertmer
Purdue University

Krista D. Simons
New Mexico State University

Introduction

Problem-based learning (PBL) has been shown to have positive effects on students enrolled in medical programs and, more recently, at the K-12 level. One potential benefit of using PBL in K-12 education is the improvement of students' self-regulation skills. Self-regulation skills refer to "students' self-generated thoughts, feelings, strategies, and behaviors, which are oriented toward the attainment of goals" within the learning process (Schunk & Zimmerman, 1998, p. viii). In this study, guided interviews were used to investigate the experiences of low self-regulated learners in a problem-based learning environment. Low self-regulated learners were identified through the Self-directed Learning Inventory (Metiri Group, 2002) completed at the beginning of the school year.

Literature Review

Problem-Based Learning

Problem-based learning (PBL) is a student-centered instructional method driven by an ill-structured, realistic problem on which students collaborate in order to develop feasible solutions. PBL creates a learning environment where students are active in the learning process. Students propose investigative questions, explore and research relevant information, and suggest solutions (Lambros, 2004). In addition, the teacher assumes the role of facilitator or guide, assisting students through the learning process with prompts, guidance, and resources (Savin-Baden, 2003).

Benefits for K-12 Students

The majority of research on the PBL method has examined the benefits for medical students; however, emerging research lends support to the use of PBL in K-12 contexts. Evidence from current studies conducted in the K-12 environment has shown that using PBL instruction can increase student motivation (Koszalka, Graboski & Kim, 2001; Pedersen, 2003), problem solving skills (Ben-Chaim, Fey, Fitzgerald, Benedetto, & Miller, 1997), long-term retention (Albanese & Mitchell, 1993; Gallagher, 1997; Norman, 1991), self-efficacy (Cerezo, 2004), transfer of new skills (Pedersen & Liu, 2002), and collaboration skills (Achilles & Hoover, 1996).

One potential benefit of problem-based learning is the improvement of students' self-directed and self-regulation learning skills (Hmelo-Silver, 2004; Zimmerman & Lebeau, 2000). While these two terms often are used interchangeably to reflect student-chosen strategies for learning, emphasizing learner control over the learning process, one distinction between the two terms is the scope. Self-directed learning usually takes place with help and interaction from others (Knowles, 1975), while self-regulation refers to a more internalized process comprising "students' self-generated thoughts, feelings, strategies, and behaviors, which are oriented towards the attainment of goals" (Schunk & Zimmerman, 1998, p. viii). For the purposes of this paper, we will use the term self-regulation due to its emphasis on the internal management of the PBL process.

Self-Regulation in Problem-Based Learning

Self-regulation is a characteristic commonly required for students to be successful in PBL contexts (Hmelo-Silver, 2004; Zimmerman & Lebeau, 2000), yet some authors argue that PBL also enhances students' ability to self-monitor (Belfiore & Hornyak, 1998; Lan, 1998; Zimmerman & Paulsen, 1995). According to Hmelo-Silver (2004), problem-based learning helps students gain knowledge while developing self-regulation strategies. While in a problem-based learning environment, students investigate a problem through research and questioning, establish a plan for solving the problem, and take the steps necessary to provide a workable solution. In order to successfully complete these tasks students must engage in these self-regulation skills throughout the entire process. Students use self-regulation skills while dissecting the problem as a group, extracting pertinent information, and creating a list of information they still need to find. Once the information has been divided among different group members, students use additional self-regulation skills in order to investigate different resources, bring the information back to the

group, and evaluate the avenues that still need to be explored or that need additional information (Torp & Sage, 2002). All of these activities within a problem-based learning environment call for self-regulation skills. "The SDL [self-directed learning] emphasis is a distinguishing feature of PBL. In PBL, students become responsible for their own learning, which necessitates reflective, critical thinking about what is being learned" (Hmelo-Silver, 2004, p. 239). Problem-based learning environments are learner-centered, asking students to apply knowledge they learn in a self-regulated manner. This leads to one of the overall purposes of engaging students in a PBL unit; that is, to build students' ability to self-direct their own learning and become life-long learners (Hmelo-Silver, 2004).

Self-regulation skills may influence students' abilities to solve problems (Swanson, 1990). Students with self-regulation skills possess the ability to "select, control, and monitor strategies needed to achieve desired learning goals" (Ertmer & Newby, 1996, p. 1). When high self-regulated learners approach a topic they do not understand, they are better able to apply strategies to learn the information than a learner with lower self-regulated skills (Swanson, 1990). However, some research (Belfiore & Hornyak, 1998) has shown that students of low-achieving status, who also tend to be low self-regulated, have the ability to successfully solve problems and participate in complex learning activities, such as PBL units. However, they usually require more guidance for setting their own goals and monitoring their own growth, which can be accomplished through such scaffolding tools as checklists (Belfiore & Hornyak, 1998). Although some studies have shown a possible correlation between low-achievement and low-self-regulation (Salili & Lai, 2000), others have found no significant differences between high and low achieving students and their use of self-regulated strategies (Rao, Moely, & Sachs, 2000). Further research is required to investigate this possibility, especially at the K-12 level (Chuang, & Pape, 2003).

One difficulty with PBL is the challenges it provides for students with low levels of metacognition, an important factor in self-regulation (Hmelo & Lin, 2000). "Metacognition is essential to function well in complex environments and therefore [students] must be supported in developing a sense of responsibility for their management of problem-solving tasks" (Greening, 1998, p. 7). A study by Swanson (1990) indicated that high metacognitive ability correlated with a student's ability to solve problems, regardless of aptitude. Therefore, it is important to equip all students, regardless of ability, with metacognitive skills (Swanson, 1990). In another study, low-achieving students performed at, or above, the level of average achieving students within anchored instruction, one type of problem-solving environment. The authors attributed these results to five main components of anchored instruction: the motivation stemming from working on real problems, students incorporating prior knowledge and being metacognitive, the collaborative environment, the guidance provided by expert teachers, and the mini-lessons incorporated to supply students with the necessary content knowledge (Bottage, Heinrichs, Chan, Mehta, & Watson, 2003). Although research has examined low-achieving K-12 students in different educational environments (Bottage, et al., 2003; Belfiore & Hornyak, 1998; Swanson, 1990; Eom & Reiser, 2000), research is limited on how low self-regulated K-12 students manage learning, especially while in PBL environments. This study investigated the perceptions of low self-regulating students regarding how they managed their learning within a problem-based learning environment.

Purpose

Problem-based learning (PBL) usually requires greater student responsibility and activity than traditional learning (Hmelo-Silver, 2004). Because low self-regulated students may lack the ability to guide their own learning (Swanson, 1990), they may have difficulties within a PBL environment. It is important to understand the strategies that low self-regulated students use in a PBL environment in order to design future environments that enable success for these students. In order to study the strategies and experiences of students with low levels of self-regulation in a problem-based learning environment, we posed the following research questions:

1. What are the experiences of low self-regulated learners in problem-based learning environments?
   - How do low self-regulated learners manage the learning process in a problem-based learning environment?
   - What do low self-regulated learners perceive they learned in problem-based learning environments?
2. What are the perceptions of low self-regulated learners of the benefits and challenges of problem-based learning?

Method

Participants and Context

This exploratory study was designed to investigate the experiences and perceptions of low self-regulated learners in a problem-based learning environment. The five males and five female students selected for this study were all six-graders from a rural district in the Midwest and participated in the same problem-based learning units with one of two collaborating language arts teachers. Students for this study were selected based on their self-

directed learning scores taken at the beginning of the year (details regarding selection procedures are presented later).

The two Language Arts teachers collaborated and co-planned three PBL units during the year, one implemented each trimester. In general, the Language Arts standards being met through these units addressed persuasive communication skills, writing skills, research/note taking skills, and oral presentation skills. The first problem-based learning unit placed an emphasis on improving the local community. Students were grouped and charged with selecting a problem in their community, creating a change/solution, and presenting their proposal to a community official. The second problem-based learning unit was based on converting the old library into a museum. Students developed an exhibit idea and competed to have their exhibits displayed in the museum. Students were required to individually create their own museum exhibits and to produce a persuasive argument detailing why their design should be chosen. Students were then grouped together in their math classes and each group selected one of the ideas to develop further. Once the idea was selected, students created a blueprint of their exhibits using scales and proportions. The final problem-based learning unit addressed the deforestation of rainforests. The students selected one of eight reasons why they wanted to save the rainforests, ranging from the medicines it provides to the possible extinction of certain animal species. They separated into groups based on the reason they selected. The groups researched their reasons for saving the rainforest, created a presentation, and defended their stance to their classmates.

Procedures

In fall 2004, all sixth grade students (n=152) completed the Self-Directed Learning (SDL) inventory (Metiri Group, 2002) prior to participating in any of the PBL units. The instrument measured the following self-rated skills: goal setting/strategic planning, self instruction/imagery (forming mental pictures), self monitoring, help seeking (self-initiated attempts to receive assistance), self evaluation, and adaptivity (adjusting when confronted with errors).

Students with a low SDL score, defined as at least one standard deviation below the mean, were identified as possible students to interview. The research team consulted with the teachers to select students who would be willing to speak out and who could afford to miss a portion of class time. Six students were interviewed in the middle of the school year after completing two problem-based learning units while the other four students were interviewed at the end of the year after the third problem-based learning unit had been completed.

The selected students were interviewed by one of the first two authors using a semi-structured protocol. The interviews lasted for ten to twenty minutes. Questions covered their attitudes towards PBL, projects they completed, and descriptions of the learning process. For instance, one question asked, “Do you like these PBL projects more or less than normal class activities?” Student interviews were transcribed and coded based on key words related to our research questions, such as group interactions and attitudes towards PBL.

Results and Discussion

Experiences in PBL

When low self-regulated students discussed their experiences in a problem-based learning environment, common trends were found throughout the interviews. Students discussed how they managed the learning process, their perceptions of the benefits and challenges to working in a PBL environment, including working in groups, as well as their perceptions of what they had learned.

Managing the process. Based on the first research question, common trends were found among low self-regulated learners’ perceptions of their experiences in problem-based learning environments, specifically concerning the management of their own learning. Students with low self-regulated skills turned to a variety of support mechanisms during the problem-based learning units, although asking the teacher for help was most frequently mentioned: eight of the ten students mentioned using this strategy. One student recalled asking the teacher for assistance he/she could not move forward; “I had to ask my teacher. She fixed it.” Five students described relying on their own problem-solving abilities. One student described how he overcame being stuck on a problem by “just using [his] brain.” When he was stuck or confused, he described reasoning the situation out in his head by thinking of alternative solutions to the problem.

One potential concern for students within PBL relates to those who lack organizational and monitoring skills, or do not complete assignments on time (Belfiore & Hornyak, 1998). Out of the ten interviewees, five students either had not turned an assignment in or turned it in late. Students who did not complete assignments on time attributed such behaviors to their frequent absences or merely being uninterested in the completion of the project. One student attributed the lateness to his “forgetting my laptop at home,” while another student attributed the lateness to, “I just didn’t [put] the time into it. I did it at the last second. [I was] just trying to get it completely finished.” It is plausible this stemmed from a lack of self-regulation, because self-regulation skills include organizational and monitoring components.

This result is supported by the literature; researchers have noted that students with low self-regulated skills often have a difficult time finishing assignments due to lack of organizational and monitoring skills (Zimmerman & Kitsantas, 1997). Additional guidance and scaffolds may enable these students to accomplish their goals in a problem-based learning environment (Schunk & Ertmer, 1999), which could be achieved through the use of more checkpoints throughout the process.

Another part of managing the process within problem-based learning requires metacognitive skills. Metacognition enables students to think about their own learning, the strategies they are applying, and what they can do to adapt the process when it is not working. Typically, low self-regulated students lack the metacognitive abilities to direct the learning process and take charge of their own learning (Swanson, 1990).

However, students did occasionally appear to use metacognitive skills. Seven students mentioned they realized the need to search for more information to prepare an adequate presentation. Another student noted she needed to think of the situation in an alternative way to solve the problem. The student stated the need for thinking harder by saying to herself, "think of something else, think of something else." This evidentiary support suggests that some students were capable of using metacognitive skills, which is a promising sign for their success in future PBL experiences.

Perceptions of learning concepts. During the interviews we also asked students to describe what they learned from their problem-based learning experiences. Throughout the problem-based learning units, students worked on both mathematics concepts related to proportions and scales, as well as language arts standards related to communication, research, oral presentations, and persuasive writing. Most low self-regulated students lacked the ability to articulate their understandings of the specific concepts taught and learned in language arts, although in mathematics they were able to refer to specific learning goals using the appropriate mathematical terms. We suspect this was due, in part, to the difference in subject structure; where mathematics (a "hard" science) instruction is typically with precision, language arts (a "soft" science) is more viewed as more uncertain and open (Ambrose, 1998). It may be easier for students to recognize the specific goals of mathematics, as opposed to the more open goals of language arts.

Through informal discussions with the teachers, another possible reason for the large variance was that the math teachers were new to PBL so they approached the unit using more direct instruction. The language arts teachers had previously used PBL, and consequently were more comfortable using more open-ended instruction where goals were not specifically reiterated on a daily basis.

In the mathematics unit students drew blueprints and learned how to calculate proportions and configure scale drawings. Half (n=5) of the low self-directed students were able to specifically articulate the processes learned in math class, explaining how to calculate proportions. "Like, what it is – 2 squares equal—1 inch equals 2 squares. And if you had 20, decrease to 10." Other students had less specific descriptions of the content learned such as "making drawings" (n=4), "measuring" (n=3), and "blueprints" (n=1), but still used appropriate mathematical terms.

In language arts, students had more difficulties articulating specific concepts they had learned from the problem-based learning units. These units were designed to help students learn how to write a persuasive argument, give an oral presentation, and write a research paper. Three students actually mentioned they "haven't learned anything" related to language arts. Some students (n=4) mentioned they believed they learned how to research more proficiently, while other students noted that they learned how to make decisions (n=1), how to revise his/her writing (n=1), how to gather information (n=1), how to use bigger words (n=1), how to type faster (n=2), the importance of providing details and supporting writing with arguments (n=1), different grammatical elements (n=2), how to create a PowerPoint presentation (n=2), and what is PBL (n=2).

While more students were able to articulate their understandings of the mathematics content learned, few students were able to state the goals of the language arts units. By not having a well-defined learning objective, students may have been more confused and uncertain about the tasks they needed to complete in the problem-based learning environment (Abrandt Dahlgren & Dahlgren, 2002).

Perceptions of Benefits and Challenges

The second research question investigated the attitudes of low self-regulated learners toward problem-based learning. All students interviewed (n=10) indicated that they preferred PBL over traditional instruction. Reasons included: "it's easier," "we have a choice to do whatever we want," "I just like working with partners," and "I'm getting good at solving problems."

While students listed attributes of PBL they enjoyed, there were aspects that they perceived made learning more challenging and difficult than traditional instruction. Low self-regulated students noted frustration due to the large amount of time required (n=5), the difficulty of finding information (n=6), and the difficulty level of the project (n=5). These could all possibly be attributed to the students' lack of self-regulation. The frustrations relating to the time commitment may be because it is difficult to manage a complex project if students do not have strong

time management skills. The last frustration pertaining to the difficult nature of the project may be due, in part, to the role self-regulation plays throughout the whole problem-based learning process. Therefore, students with lower self-regulation skills may not be able to properly manage the project in its entirety, making it more difficult than traditional projects. We believe this frustration may be attributed to the lack of self-regulated strategies required in a problem-based learning environment, although more research is necessary to investigate this conjecture.

Group work. Another key component of problem-based learning is working in groups. In this study students were placed into groups of three to four in at least two of the units. Almost all students (n=8) preferred group work over individual work. When asked about their group experiences, student responses included "that makes it a lot easier cause you can split up the work" and "I like spending time with friends in my groups."

There were many positive aspects of group work that students mentioned throughout their interviews. Half of the students (n=5) referenced the help they received from group members as being important to their success and enjoyment. One student remarked, "I think [working in a group] is a lot better than working by yourself because you have other people that understand it more."

The reason that most of the low self-regulated students in this study preferred groups could be due to the age of the students, who desire more opportunities for social interaction (Lambros, 2004), or because the collaboration provides them with the opportunity to receive assistance from others. Regardless of the reason, low self-regulated students did appreciate the collaborative effort of working towards a goal. O'Connor and Jenkins (1993) proposed that teachers should replace individual assignments with more small heterogeneous group work to provide more support for struggling students.

Conclusion

Self-regulation is important to students' success in problem-based learning environments (Hmelo-Silver, 2004) and those without the necessary self-regulation skills may not flourish in these more open-ended environments. Overall, low self-regulated learners have difficulties participating in complex learning environments, such as those involving problem-based learning, due to a lack of ability to plan, monitor, and evaluate their learning (Ertmer, 1995). The low self-regulated learners in this study expressed specific difficulties thinking of alternate learning strategies, monitoring the project to finish on time, engaging in more ill-defined problems with confidence, planning their learning processes, and dealing with the challenging nature of problem-based learning. Low self-regulated learners need support, guidance, and assistance to manage projects in a given time frame in problem-based learning classrooms (Biemiller et al., 1998). Therefore, we suggest the use of tools such as checklists, worksheets, webquests and recommended websites, notecards, and guiding questions to assist low self-regulated learners (Biemiller et al., 1998). With the proper fading of such guides and instruction on metacognitive skills, low self-regulated learners may be able to obtain more self-directedness in such open-ended learning environments (Belfiore & Hornyak, 1998). At first, it may be necessary for students to receive "closer teacher attention" when using self-regulated strategies (Mason, Harris, & Graham, 2002). One interviewee said she now performs many of the same strategies in other classes because it helps her with researching and managing her learning. If possible, we recommend collaborating with team teachers to help implement these strategies in every learning situation (Mason et at.). By equipping low self-regulated students with these skills, they will be better able to manage the learning process on their own.

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Promoting Learning Interest in Pedagogical Agent Embedded Learning.

Sanghoon Park, Ph.D.
Northwestern State University of Louisiana

Abstract

Positive emotion plays a critical role in learning process. Learning interest among positive emotions, especially, initiates learners' motivation and further improves learners' achievement. This paper explored two research questions based on the distinction between individual interest and situational interest: (1) what factors affect learning interest in pedagogical agents embedded learning, and (2) How to design pedagogical agents to improve learners' interest and attitude. In addition, this paper further investigated the effects of pedagogical agents developed using factors identified above on learning interest, achievement, and attitude.

Learning Interest

Interest increases learning. Promoting interest in the classroom increases learner's learning motivation and improves the use of learning strategies. (Keller, 1983; Pressley, El-Dinary, Marks, Brown, & Stein, 1992; Sweet, Guthrie, & Ng, 1997). Interest also plays a significant role in the learning process, determining what to learn, and how to learn the chosen information (Alexander & Jetton, 1996; Garner, 1992). Therefore, the issue of how to increase learner's interest is directly related to initiating learner's motivation, and further improving learner's achievement.

The Framework of Research on Interest

Renninger et al (1992), in their book entitled "The role of Interest in Learning and Development", provided an integrated theoretical framework based on the distinction between individual interest and situational interest. This framework has been used as a theoretical ground for studies on learning interest.

The distinction between individual interest and situational interest has been drawn as a framework in many empirical studies on interest (Garner et al., 1989; Garner et al., 1992; Harp & Mayer, 1997, 1998; Hidi, 1990, 2001; Hidi & Anderson, 1992; Hidi & Baird, 1986; Krapp, 1999, 2002; Krapp et al., 1992; Schiefele, 1991, 1992, 1996, 1998, 1999; Schiefele & Krapp, 1996; Schraw, 1998; Schraw et al., 2001; Schraw & Lehman, 2001; Wade et al., 1993). From the view of individual interest, interest is implied as a characteristic of person. It is specific to individuals, developed slowly, tends to be long lasting, and is triggered by an individual's predisposition (Renninger et al., 1992; Schiefele, 1998; Schraw & Lehman, 2001; Silvia, 2001). For example, learners who are interested in a topic or an activity pay more attention and acquire more knowledge than participants without such interest. Individual interest can be assessed through a learner analysis process by asking several background questions or administering a simple questionnaire. However, it is not easy to take into account individual interest in designing learning material because individual interest refers to a student's relatively enduring preference for different topics, tasks, or contexts (Krapp, 1999; Tobias, 1994).

Krapp (1992) insisted that situational interest be a prior foundation of individual interest. According to him, when the content of the learning material is not a subject area in which the learner has established individual interest, the interesting factors in the subject learning situation is necessary to awake the interest for a short or longer period of time. This interest is defined as situational interest and the central psychological process "Internalization" supports the transformation process of situational interest into long-lasting individual interest as described in Figure 1. Situational interest is generated as a result of interestingness of situation. It is caused primarily by certain conditions and concrete objects in the environment, triggered by environmental factors, elicited by certain aspects of a situation, and it is assumed to contribute to the interestingness of the situation (Harp & Mayer, 1997; Hidi & Anderson, 1992; Krapp, 1999, 2002; Renninger et al., 1992; Schiefele, 1992, 1996; Schraw & Lehman, 2001; Silvia, 2001). While individual interest is a relatively stable evaluative orientation towards certain domains, situational interest is formed if an emotional state aroused by specific features of an activity or a task. The following Figure 1 illustrates the relationship between individual interest and situational interest. This study grounded its framework of inquiry in this relationship.

As illustrated in Figure 1, the relationship between individual interest and situational interest is hardly clear. Both individual interest and situational interest are combined together in certain learning circumstances to represent the interest as a psychological state within a person.

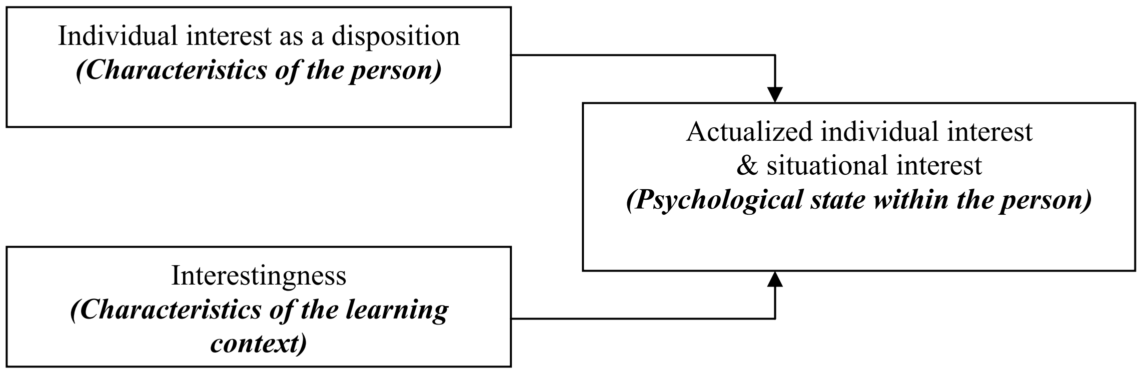

Figure 1. Three approaches to interest research (Krapp et al., 1992).

Individual Interest

Individual interest is topic specific and persists over time (Hidi, 1990; Krapp et al., 1992). Individual interest is defined as people's relatively enduring preferences for different topics, tasks, or contexts (Krapp, 1999; Tobias, 1994). Schiefele (1991, 1999) further distinguished between two subcomponents of individual interest; a feeling-related component and a value-related component as illustrated in Figure 2.

Feeling-related valences refer to the feelings that are associated with an object or an activity, for instance, involvement, stimulation, and flow. It occurs when an individual experiences positive affect and emotions in conjunction with a particular topic or activity. It is presumed that these positive feelings provide a strong motivational incentive to engage in the activity (Schraw & Lehman, 2001). Value related valences refer to the attribution of personal significance of importance to an object and activity. It is presumed that value related interest increases engagement because an activity or body of knowledge is judged to be salient to one's goal (Sansone, Weir, Harpster, & Morgan, 1992; Schraw & Lehman, 2001). Since those two aspects are highly correlated each other, it is hard to determine what aspect of components affect individual interest (Schiefele, 1991, 1999). However, it is obvious that some learners prefer to learn specific topics or participate in specific activities because they like it primarily based on feeling, and others also do because they think the activity is important for some future purpose.

Situational Interest

Situational interest is elicited by aspects of a situation, such as novelty or intensity, and by the presence of a variety of human interest factors contributing to the attractiveness of different types of contents (Krapp, 1999; Tobias, 1994). Most of the research on situational interest has focused on the characteristics of academic tasks that create interest (Hidi & Baird, 1986). Features that have been found to arouse situational interest and promote text comprehension and recall are: personal relevance, novelty, activity level, and comprehensibility. Situational interest is often considered to precede and facilitate the development of individual interest (Krapp et al., 1992).

Most interest research has focused on various aspects of situational interest. As Schraw and Lehman (2001) indicated, one of the reasons is that situational interest is more amendable to change compared to individual interest. They further categorized three general aspects of situational interest as text-based, task-based, and knowledge based. Text-based interest refers to the feature of the text information that affects interest. Task-based interest involves task manipulations or encoding instructions that increase interest. Finally, knowledge-based interest refers to the aspects of learner's knowledge-base that promote interest. Seductive detail, which refers to the highly interesting but unimportant text segments, is considered one of the factors in text-based aspects of situational interest.

Regarding situational interest, the concept of cognitive interest and emotional interest was proposed by Kintsch (1980). Cognitive interest adjuncts such as explanative summaries, influence learner's cognition by promoting the reader's structural understanding of the explanation. On the other hand, emotional interest is explained by that the addition of interesting but peripherally relevant material to a textbook lesson that energizes the learner so that they pay more attention and learn more overall (Harp & Mayer, 1997). According to the definitions of cognitive interest and emotional interest, these are interest state derived by specific feature of a learning material.

Therefore, both of cognitive interest and emotional interest need to be counted as two aspects of situational interest as shown in Figure 2.

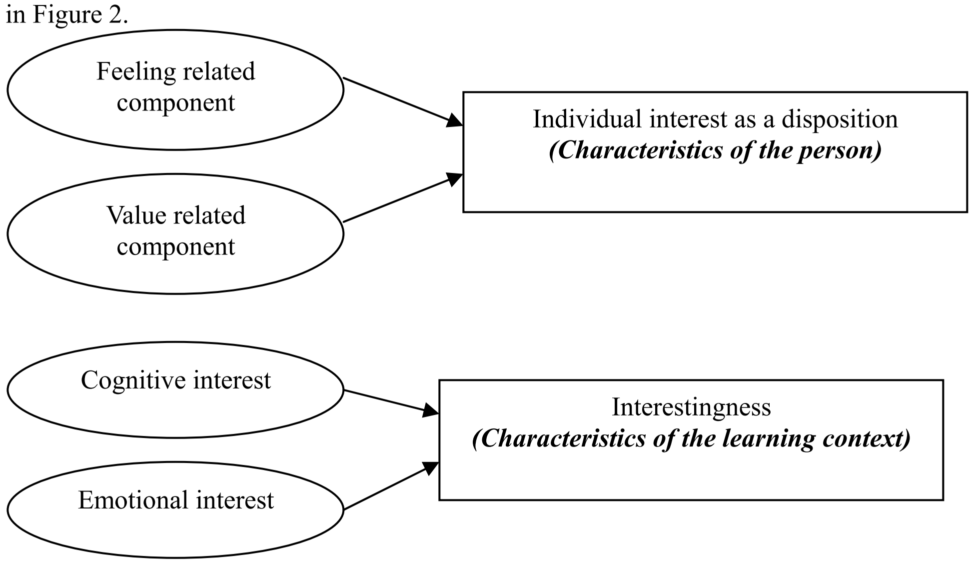

Figure 2. Individual interest and Situational interest.

Pedagogical Agent and Learning Interest

Pedagogical agents are animated life-like characters designed to facilitate learning in computer-mediated learning environments (Johnson et al., 2000). Regarding the effects of pedagogical agents, researchers using lifelike pedagogical agents have indicated positive effects on learner's attitude toward learning and performance (Baylor, 2002a, 2002b; Baylor & Ryu, 2003; Moreno et al., 2001). Also researchers have found positive effects of pedagogical agents on learner's interest and motivation. Two explanations were suggested in regard to the positive effects of pedagogical agents on learner's interest (Baylor & Ryu, 2003). The first reason was agent persona. Learners tend to like a pedagogical agent because of the agent's character or personality based on agent's persona composed of image, animation, voice, and emotional expressions. The second reason was the information provided by agent. Learners reported that they liked an agent because they found the quality of the message delivered by the agent was informative and helpful. The research using agents with evasive emotion and no motivational support also found that learner's interest was aroused from the agent's persona and information delivered by agent (Warren et al., 2004). Therefore, the variables affecting learner's interest could be categorized into two dimensions, one is an agent's persona and the other is information delivered by the agent. In this paper, the variables affecting learner's interest are described in detail in terms of the persona of pedagogical agents and the message delivered by the pedagogical agent.

Pedagogical agent's persona

The key characteristics that constitute a pedagogical agent's persona include its propensity to be engaging, person-like, credible, and instructor-like (Baylor & Ryu, 2003). Engaging personas of agents facilitate the learner-agent relationship and motivates the learner to be involved in the learning task. Person-like personas of agents form a viable relationship with the learner. Credible personas of agents make learners confident in the agent and help them recognize the agent as trustworthy, competent, and consistent in behavior. Finally, instructor-like personas of agents serve as a pedagogical mentor to effectively represent the content and pedagogy (Baylor, 2000). Media features such as voice, emotional expression, gesture, image, and animation are integrated to create such personas.

The effect of a pedagogical agent on interest is explained also by social presence theory. According to Short, Williams, and Christie (1976), social presence is a subjective quality of the communication medium and can be a function of both verbal cues (e.g. tone of voice) and nonverbal cues (e.g. facial expression, direction of gaze, posture, and dress). Hence, a pedagogical agent is considered to have higher social presence than other computer mediated media, because pedagogical agents provide nonverbal cues as well as verbal cues, which can lead to promoted learner interest.

Therefore media features are essential in terms of constructing agent personas and indicating social presence of an agent to promote learning interest. Voice has been suggested as a key aspect for enhancing agent persona. In fact, the voice feature has been found to be a critical element for agent-based learning environment. Prior research has indicated that voice has a superiority effect to visual appearance for communication in computer-based media (Mayer & Moreno, 1998; Moreno & Mayer, 1999), and with pedagogical agents in particular. While there are consistent results that voice (in conjunction with text) is a key aspect for enhancing agent persona, the role of agent image and animation is not proven (Baylor & Ryu, 2003). However, given the importance of emotional expression by an agent, animation would be necessary for an agent to demonstrate facial expressions. Animation with emotional expression increases the agent's persona of credibility and also improves social presence of the agent by increasing non-verbal behavior. Baylor (2003) found that animation provides the most positive impact for an agent to be perceived as engaging, because it contributes to the agent expression of a personality through non-verbal behavior, leading to be more likable, and thus more enjoyable to learn with and also more emotionally expressive.

Messages delivered by Pedagogical agent

Agents also facilitate interactive learning with learners by delivering messages to convey information. The type of information delivered by a pedagogical agent through messages is also a variable that affects learning interest. Information delivered by agent could be directly related to the learning content by signaling the structure of the learning content so that learners can promote the understanding of the content. Also, information could be interesting but irrelevant to understanding the learning content. According to Kintch (1980), information has an effect on the learner's interest in two different ways depending on the features of information and he suggested the concept of cognitive interest and emotional interest. The cognitive interest influences learner's cognition by promoting the reader's structural understanding of the content. On the other hand, emotional interest is explained by the addition of interesting and irrelevant material to understand the objectives of instructional material. However, it energizes a learner's arousal so that they pay more attention and learn more overall (Harp & Mayer, 1997, 1998). Researchers have used the term seductive detail to refer to interesting but irrelevant details that are added to a passage to make it more interesting in the reading education field. In multimedia learning, seductive detail usually is called seductive augmentation because the term "seductive augmentation" refers to not only text but also graphics, narratives, voice, animation, and text accompanied in a multimedia learning environment with the purpose of increasing learner's situational interest (Thalheimer, 2004).

As being illustrated in the previous sections, two opposing suggestions have been indicated regarding the usefulness of seductive detail. The first suggestion asserted that it energizes readers so that they pay more attention to learning and learn more overall, because it influences the learner's affect by promoting his/her enjoyment of the topic. Hence, it causes the learner to pay more attention to and encode more of the information from the material (Izard & Ackerman, 2000; Kintsch, 1980). The second suggestion contends the opposite position. It emphasizes that seductive detail disrupts the learner's construction of the material comprehension so that adding it to the material will result in decreases on tests of retention and on solutions to transfer problems (Wade & Adams, 1990).

In summary, both agent itself including agent persona and social presence, and the information delivered by the agent plays a critical role in promoting learning interest from the aspect of situational interest. In particular, media features are important factors for constructing an effective agent persona. Information type is also a critical factor because it determines the quality of information delivered by agent. Figure 3 illustrates the detailed relationship describing the features of a pedagogical agent affecting learner's situational interest.

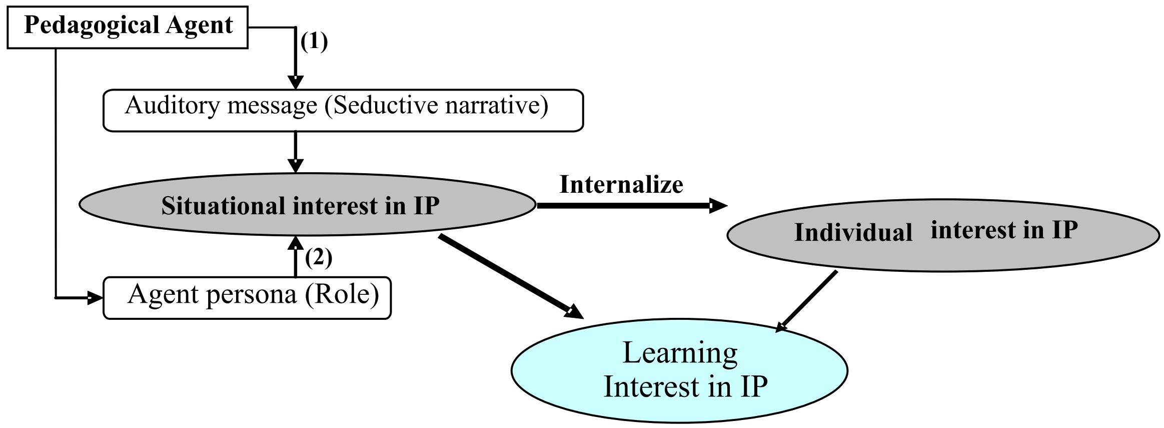

Figure 3. The features of a pedagogical agent affecting learner's situational interest

Method

Participants

A total of 123 college undergraduate students enrolling in a computer literacy classes in a large public university located in the southeastern area participated in this study. Students were voluntarily participating in the study as an optional activity of class instruction.

Independent Variable

Four levels of the source of seductive messages were implemented in this study. The first source of seductive messages was the companion role of agent. The second source of seductive messages was the instructor role of agent. Both roles of agent were employed using two pedagogical agents. The third source of seductive messages was a text message without an agent. The last condition employed no seductive message and was considered as a control condition. The contents and length of the seductive messages were identical across the four different conditions

Dependent Variable

Dependent variables included post interest, achievement, and attitude toward intellectual property module supported by a pedagogical agent. To determine the validity of achievement test items, pilot test was conducted. The purpose of pilot test was to determine the level of prior knowledge of participants on "intellectual property" and to find a size of variance among participants.

Interest measurement: Individual interest was measured from two aspects: feeling-related interest and value-related interest. The participants were asked to use the following adjectives in estimating their expected feelings ("While studying the instructional module on "Intellectual Property"/ I expect to feel…") "bored", "stimulated", "interested", "indifferent", "involved" and "engaged." When estimating value-related interest, participants were asked to use the terms "meaningful", "unimportant", "useful", and "worthless" to describe the value of the topic "Intellectual Property" to them personally. All items used 5 rating scales (ranging from "completely true" to "not at all true"). Situational interest was measured from three aspects: arousal level, involvement, and attention. In order to measure the arousal level, AD-ACL (Activation-Deactivation Adjective Check List) was used (Thayer, 1985, 1986) with modified 5-likert scale.

Involvement level was measured with intensity dimension (Reynolds, 1992) by two 5-likert scales such as "I was completely caught up in what I was studying" and "When learning from the module, I was concentrated". Lastly, "attention" sub scale from IMMS (Instructional Material Motivation Survey) will be used to measure attention level of participants (Keller, 1993).

Achievement measurement: Achievement test was designed to assess the learner's ability to solve the given problems using what they have learnt from the instructional module. To determine the validity of test items, pilot test was conducted Students participating in pilot study were given eleven test items on the first day of computer literacy class and asked to answer the questions without any information on "intellectual property." In main study, achievement test was given to measure learner's achievement at the end of the module and graded based on pre determined answer sheet. Total score ranged from 0 through 11.

Attitude measurement: The student's attitude toward to the pedagogical agent supported multimedia learning was measured using IMMS developed by Keller (1993), to measure situational components of the ARCS model. Since attention part was used to measure the part of learning interest, the remaining components such as relevance, confidence, and satisfaction, were measured. The IMMS included 36 items intended to be a situational measure of learners' motivational reactions to instructional material. The response scale ranged from one to five with nine relevance component items, nine confidence component items, and six satisfaction component items. The reliability of IMMS based on Cronbach's alpha for each subscale was Relevance: .81, Confidence: .90, and Satisfaction: .92.

Results

The effects of agent role on learning interest

A MANOVAanalysis revealed that there was a statistically significant difference of learning interest score among the four seductive message conditions, Wilks' Lambda=.709, $F(15,318)=2.81$, $p<.001$, $\eta^2=.11$. Follow-up ANOVA indicated that significant differences occurred in arousal, $F(3,119)=4.98$, $p<.01$, $\eta^2=.11$, and attention, $F(3,119)=7.01$, $p<.001$, $\eta^2=.15$. Tukey HSD follow-up procedure indicated that arousal score for the companion agent (M = 2.19, SD = .57) was significantly higher than both the text only condition (M = 1.76, SD = .60) and the no message condition (M = 1.77, SD = .60). Also, arousal score for the instructor agent (M = 2.19, SD = .68) was significantly higher than both the text only condition (M = 1.76, SD = .60) and the no message condition (M = 1.77, SD = .60). For attention, the result indicated that the attention score for the companion agent (M = 3.30, SD = .65) was significantly higher than both the text only condition (M = 2.90, SD = .47) and the no message condition (M = 2.76, SD = .66). Also, attention score for the instructor agent (M = 3.30, SD = .59) was significantly higher than both the text only condition (M = 2.90, SD = .47) and the no message condition (M = 2.76, SD = .66).

The effects of agent role on achievement

Recall test: An ANOVA on recall test scores revealed that there was no significant effect for the source of seductive messages, $F(3,119)=1.37$, $p = .27$. In order to examine the difference of total recalled number of keywords between both agent conditions and text only condition, a contrast analysis was performed. The results indicated that students in the agent conditions recalled significantly higher number of total keywords than did students in the text only condition, $t(90) = 1.99$, $p < .05$. Comprehension test: An ANOVA on comprehension test scores revealed that there was no significant effect for the source of seductive messages, $F(3,119)=.52$, $p = .67$.

The effects of agent role on attitude

A MANOVA revealed that there was a statistically significant difference of students' attitude score among four seductive message conditions, Wilks' Lambda=.782, $F(9,285)=3.37$, $p<.01$, $\eta^2=.08$. Follow-up ANOVA indicated that significant differences occurred in relevance, $F(3,119)=5.98$, $p<.01$, $\eta^2=.13$, and confidence, $F(3,119)=4.26$, $p<.01$, $\eta^2=.10$. Tukey HSD follow-up procedure indicated that relevance scores for the companion agent condition (M = 3.80, SD = .75), the instructor agent condition (M = 3.67, SD = .67), and the text only condition (M = 3.68, SD = .46) were significantly higher than the no message condition (M = 3.215, SD = .56) respectively. For confidence, the result indicated that confidence score for the companion agent condition (M = 3.30, SD = .57) was significantly higher than the no message condition (M = 2.82, SD = .67).

Discussion

Effects of seductive messages on learning interest

The students who were given seductive messages delivered by a pedagogical agent earned significantly higher scores in arousal and attention in terms of learning interest than the students who were given either the text type of seductive message or no seductive message. Students in the no seductive message condition were not given any type of seductive messages, thus their level of learning interest was lower than the other conditions. An interesting finding is that there was significant difference of the arousal score and attention score between agent delivered seductive message and text based seductive message. The result of contrast analysis confirms that

seductive messages are more effective to promote students' learning interest when they were delivered by a pedagogical agent rather than in text.

There are at least two possible explanations for why the text type of seductive message was not as effective as the one delivered by an agent.

First, the presence of an agent could affect students' learning interest. Previous research on the effects of pedagogical agent showed that users' interactions with the computer are much smoother when likable animated pedagogical agents are present. They also help students develop an emotional connection with the agent and facilitate their enjoyment of the learning situation (Dehn & Mulken, 2000). Therefore, although identical seductive messages were presented to both agent conditions and text only condition, students with agents could have been more interested in the learning of instructional material.

The second reason is that the source of the messages was different in this study. In other words, seductive messages delivered by a pedagogical agent were audio messages via agent voice that is very different from text type of message. Therefore it is also possible that students perceived a sound type of seductive message more positively then the text type of message. The second reason was not confirmed, because the sound only condition was not implemented in this study.

Effects of seductive messages on achievement

It was found that there was no significant difference of recall test score and comprehension score in terms of the achievement among four different sources of seductive message conditions. The reason why these scores were not different can be explained by the "seductive details effect".

As for the recall test, previous research on the seductive details shows that adding interesting text that is irrelevant to the theme of a descriptive or narrative passage either reduces or doesn't facilitate students' remembering of the main idea in the passage (Garner et al., 1992; Garner et al., 1989; Hidi & Baird, 1988; Wade & Adams, 1990). In this study, the mean score for text only and no message condition was 4.81 and 5.06 respectively. Although the result was not significantly different, the difference between mean scores shows that a seductive details effect occurred.

Regarding comprehension test, Harp and Mayer (1997; 1998) found that students scored highest when only basic text was presented. Consistent with their study, the result of the comprehension study in this experiment also found that students who were in the no seductive message condition scored highest among the four message conditions although the difference was not statistically significant.

However, it should be highlighted from the contrast analysis that students who were in both agent conditions scored higher than students in text only condition when the total number of keywords is considered. It means that students in both agent conditions actually recalled more keywords than the students in the text only condition. It can be inferred from this result that if the messages delivered by agents were not seductive in their content, the result might be different. It is because students actually recalled more information from an agent than they did from text although the messages were identical in all conditions. It emphasizes the importance of message design especially when pedagogical agents are embedded into computer based learning.

Effects of seductive messages on attitude

There were significant differences in relevance scores and confidence scores among the four message conditions. When seductive messages were presented, students perceived a higher relevance toward instructional material than did students in the no seductive message condition. However, students perceived higher confidence toward instructional material when only a companion role of agent was presented than the control condition where no seductive message was delivered.

With respect to relevance, the reason students perceived higher score when seductive messages were presented then no seductive message was presented can be explained by the content of the seductive messages. Although the content of seductive messages was related to the main theme, it contained unimportant information to understand the main topic. However, students were exposed to a couple of examples that illustrated some stories and cases about intellectual property. According to Keller (1983, 2002), relevance is referred as value where personal worth and future value are immersed. Therefore, it is possible that students felt connected to the content of the seductive messages when seductive messages stimulated students' perception of value by providing comment, anecdotes, or examples about intellectual property.

Confidence scores were significantly different only between the companion role of agent and the control condition where no seductive messages were given. However, no significant difference was found between instructor role of agent and control condition. Confidence is defined as a positive expectation and support for

success by enhancing students' belief in their competence (Keller, 1983, 2002). The fact that students recognized a companion agent and an instructor agent differently in this study implies that students felt more competence with a companion agent, because delivered messages and voice of the companion agent were consistent with students' perception of an agent as a companion. However, it also should be noted that the difference on confidence scores between the companion agent and the instructor agent was minimal.

Pedagogical agents, learning interest, achievement, and attitude

In regard to the difference between the companion role of agent and the instructor role of agent, there were no significant differences in terms of learning interest, achievement, and attitude. This result is not consistent with those of earlier studies on the role of pedagogical agents which have found that agent perception and learning outcomes are different depending on what role of agent is implemented (Baylor, 2003).

One possible reason why no significant difference was found between the roles of the pedagogical agent is that students did not recognize the agent persona of each agent. An agent has its character or personality based on students' perceived persona combining image, animation, voice, and emotional expressions. In this study, although image, voice, and emotional expression were different between two agents, the messages delivered were identical each other. On the other hand, the study conducted by Baylor (2003) used different types of messages for each different role of agent. For example, in terms of messages, the expert agent provided information whereas the motivational agent provided encouragement and support, and the mentor agent provided both information and encouragement/support.

Therefore, differentiating the delivered messages plays an important role for students to acknowledge the role of agent. However, identical seductive messages were employed to control the effect of seductive messages in this study. It led research to find no differences in regard to the learning interest, achievement, and attitude between the companion role of agent and the instructor role of agent.

Conclusion

Future research needs to move in four directions. First, as this study mainly focused on the effects of emotional interest, it is still necessary to consider the other component of situational interest that is cognitive interest. It has been suggested that cognitive interest adjuncts such as explanative summary, illustrations or messages influence students' cognition by promoting structural understanding of the expository passage. And the attainment of structural understanding promoted a sense of positive affect about the passage. Therefore situational interest is affected by cognitive interest as well as emotional interest. This line of study will provide researchers with a big picture of how situational interest is promoted from two aspects, emotional interest and cognitive interest.

Second, one of the assumptions in this study was that students will perceive the role of agents differently. Although no difference was found, many studies observed agent characteristics such as gender and age affect differently on the perception of students. Especially, the effects of messages were found to be very important in this study when they are delivered by agents. Therefore, future study is needed to examine how the cognitive interest messages or emotional interest messages affect students' perceived situational interest when these messages are delivered by agents.

Third, the contents of this study were mainly about intellectual property that was a type of expository information. Future study should extend the scope of material content to other types of text information such as math or science content where students actually need to apply what they have learned from the instructional material. Also, the narrative type of text needs to be tested. Previous research shows that the effects of seductive details/augmentation are different in opposite way depending on whether the context is expository information or narrative biography text. When a narrative biography text was used as a main text, none of previous studies showed the seductive-augmentation effect. In fact, the significant comparison showed that seductive augmentations helped learning of main ideas (Garner & Gillingham, 1991; Schraw, 1998).

Fourth, individual difference needs to be considered in future research. If students' pre interest level is different at the beginning of instruction, the use of seductive details might be an effective strategy to improve students' situational interest so that students will pay attention to the instructional material. But if students are already highly interested in the instructional material, there will be no need to improve students' situational interest.

Improving learning interest for successful learning is not a simple process. Many psychological constructs are involved from an individual aspect and also a situational aspect. As an instructional designer, therefore, it is necessary to approach the issue of learning interest from both of these aspects.

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Problem-Based Learning (PBL) and Teachers' Beliefs regarding Technology Use

Sung Hee Park
Ewha Womans University

Peggy A. Ertmer
Purdue University

Krista D. Simons
New Mexico State University

Introduction

Although computers and other technologies have spread into every part of society, the integration of technology into our schools has been much less successful due to a number of barriers, both external (e.g., access to computers, software, and planning time) and internal (e.g., teachers' preferred teaching methods, underlying beliefs about teaching and learning) to teachers (Ertmer, 1999). While access and training issues have been mitigated in recent years (Market Data Retrieval, 2002), teachers' beliefs have only recently come to the fore. In order to promote favorable beliefs about classroom technology use, teacher educators are beginning to recognize the importance of engaging preservice teachers in authentic technology experiences (Albion & Ertmer, 2002; Windschitl, 2002). Recently, problem-based learning (PBL) has been highlighted as a potentially effective approach for changing preservice teachers' beliefs (Levin, 2001; Tatto, 2003). By engaging preservice teachers in authentic problem solving involving collaborative decision-making, supported by technology, it is thought that PBL can serve as a catalyst for shifting teacher beliefs (Albion, 1999; Levin, 2001; Lundberg & Levin, 2003).

Teachers' Beliefs

Labeled a "messy construct" by Pajares (1992), beliefs are still considered the "best indicators of the decisions individuals make throughout their lives" (p. 307). Kagan (1992) cited significant evidence supporting the relationship between teacher beliefs and their decisions about classroom practice. Specific to technology use, Niederhauser and Stoddart (2001) described patterns of use that were consistent with teachers' personal beliefs about curriculum and instructional practice. Going one step further, other researchers (Becker, 1994; Berg, Benz, Lasley, & Raisch, 1998) have documented an association between low-level technology use and teacher-centered beliefs and practices, as well as between high-level uses and student-centered beliefs. For example, teachers who have student-centered beliefs tend to use multiple technology applications with problem-solving tasks (concept mapping software, Internet search engines) while teachers with teacher-centered beliefs tend to use single technology applications to present information (e.g., PowerPoint). It is becoming increasingly evident that if our future teachers are going to be prepared to use technology in ways that empower students, their pedagogical beliefs will need to shift from a traditional teacher-centered pedagogy to one that is more constructivist and student-centered (Lundberg & Levin; 2003; Richardson, 2003).

Teachers' Beliefs Regarding Technology Use

Teachers' beliefs have been emphasized previously especially in terms of teacher efficacy beliefs, expectations about students' achievement, and students' motivation (Bandura, 1997; Gibson & Dembo, 1984; Schunk, 1991; Woolfolk & Hoy, 1990). However, little research has been conducted focusing on teachers' beliefs regarding technology use. Nonetheless, there is some research to suggest that there is a relationship between teachers' technology uses and their pedagogical beliefs (Becker, 2001; Honey & Moeller, 1990).

Parr (1999) and Tillema (2000) noted that encouraging teachers to develop new beliefs and stick with them is difficult. Even when teachers have a strong set of pedagogical beliefs, these ideas are often challenged and overruled by the conditions of the teaching environment. In other words, a pre- or inservice teacher who believes

strongly in student-centered learning may quickly adopt a teacher-centered approach when faced with an overloaded schedule, lack of administrative support, or other barriers in the classroom (Ertmer, Ross, & Gopalakrishnan, 2000). Although teachers agreed that technology makes their home, work, and school lives easier, technology integration is considered a difficult process (Parr, 1999; Tillema, 2000). Because computer technology is a relatively new phenomenon in the school environment, teachers still consider technology integration to be a complex process.

According to Miller et al. (2003), teachers' beliefs about technology are comprised of three related, but independent components: pedagogical beliefs about teaching and learning, self-efficacy beliefs about technology use (i.e., teachers' confidence for using technology), and beliefs about the perceived value of computers for student learning. Russell, Bebell, O'Dwyer, and O'Connor (2004) found these three components to be the main predictors of teachers' classroom technology uses.

Current literature suggests that teachers' beliefs can be changed through practices that emphasize reflection on personal beliefs, hands-on experiences, and engagement in authentic problems from K-12 classrooms (Copeland & Decker, 1996; Derry, Siegel, Stampen, & the STEP team, 2002; Tochon, 1999). For example, Derry et al. documented successful belief change after engaging preservice teachers in authentic displays of teaching (e.g., real cases, video cases). Through these authentic experiences, preservice teachers developed a better understanding of constructivist practices, became more effective at implementing constructivist methods, and achieved meaningful reflections on the nature of teaching and learning. Based on these results, problem-based learning (PBL) has been advocated as an effective approach for impacting teachers' beliefs.

Problem-Based Learning (PBL)

A PBL learning approach is based on the use of ill-structured problem situations requiring students to develop expertise in information seeking and decision-making processes in order to solve the problems. Because the problem situations are messy, confusing, and complex, students need to gather information in order to understand, define, and solve the problems. During an authentic problem solving process, students are able to set their own goals and develop their own approaches. Under the guidance and coaching of a skillful teacher, students work collaboratively to inquire, investigate, and plan their learning activities (Torp & Sage, 1998).

Impact of PBL in Teacher Education

An increasing number of research studies demonstrate the value of PBL for enhancing students' critical thinking skills, increasing motivation, improving problem solving skills, and facilitating social skills through group work (Duch, Groh, & Allen, 2001). As a catalyst for examining beliefs, PBL enables preservice teachers to recognize different perspectives and encourages them to articulate, defend, or change their current beliefs about classroom practice. That is, using problems and issues from K-12 classrooms, preservice students can connect their academic knowledge to issues in the field and thus examine their beliefs while engaging in problem solving, critical thinking, collaboration, and decision making (Lundberg & Levin, 2003).

For example, Derry et al. (2002) found that preservice teachers gained more content knowledge in an educational psychology class with the PBL STEP (Secondary Teacher Education Project) approach than previous students taught in traditional ways. The STEP approach provided PBL activities and introduced various PBL video cases. Preservice teachers watched video cases of student interviews before and after instruction in the real K-12 classroom and tried to understand why the students in the video case failed to learn. In the posttest, preservice teachers applied more appropriate concepts and described them in more sophisticated ways than on the pretest.

Some studies have reported limited changes in preservice teachers' beliefs after participating in their teacher education programs. Although the changes were limited, experiences with the cooperating teachers was found to be the most influential factor impacting their changes (Anderson, Smith, & Peasley, 2000; Borko & Mayfield, 1995).

Therefore, to develop and change preservice teachers' beliefs in teacher education, it is suggested that preservice teachers engage in problems and issues from K-12 classrooms, enabling them to connect their academic knowledge to their field experiences and then to examine their beliefs during the process (Richardson, 2003).

The PBL approach using K-12 problems to contextualize important issues presents one method for changing preservice teachers' beliefs. Although many educators have realized the importance of PBL, they have hesitated to implement PBL in their classrooms because of time, a lack of experience, and fear of assuming a facilitative role (Goodnough, 2003; Hemelo-Silver, 2004; Park, Ertmer, & Simons, 2005; Torp & Sage, 2002). However, PBL can provide an opportunity to change preservice teachers' beliefs by motivating and engaging preservice teachers in reflection on their beliefs (Lundberg & Levin, 2003; Pierce, 1999; Pierce & Lange, 2001; Sage, 2000).

Pajares (1992) noted that it was hard to measure beliefs accurately. Therefore, Tatto and Coupland (2003) suggested that multiple data sources be used to measure teachers' beliefs including surveys, observations of teaching practices, reflections, and interviews. Specifically for preservice teachers, they suggested including document analysis of instructional lesson plans across time. Because preservice teachers have limited classroom teaching opportunities, instructional lesson plans may offer a reasonable substitute for observing classroom teaching practices.

Teachers' teaching practices do not rely on impulse, but are directed toward certain preplanned outcomes (Putnam & Duffy, 1984). That is, lesson plans as a preplanned outcome, provide important information of a teacher's intended teaching practices. For example, Kitsantas and Baylor (2001) examined teachers' instructional lesson plans to determine their intended teaching practices. Peterson and Bond (2004) investigated differences in students' instructional planning skills based on PBL approaches using different delivery methods (online vs. face-to-face) in teacher preparation. Previously, when instructional lesson plans were used (Kitsantas & Baylor, 2001; Peterson & Bond, 2004), the researchers evaluated the completeness of the plans rather than the theories underlying them such as behaviorism or constructivism. Furthermore, little research was found that analyzed instructional lesson plans as an indication of intended teaching practices associated with beliefs. In this study, I examined preservice teachers' instructional lesson plans as an indication of their intended teaching practices, and as representative of their beliefs about teaching, learning, and technology.

Although some literature is available regarding pre-service teachers' beliefs, previous research has not investigated how to change beliefs regarding technology use. Specifically, little, if any, research has investigated how PBL might impact pre-service teachers' beliefs regarding technology use (Hmelo-Silver, 2004; Tatto, 2003).

The purpose of this study was to examine the impact of problem-based learning on teachers' beliefs regarding technology use. Specifically, this study was guided by these primary research questions:

1. What is the impact of problem-based learning on preservice teachers' beliefs regarding technology use?
    a) What is the impact of PBL on pre-service teachers' pedagogical beliefs?
    b) What is the impact of PBL on pre-service teachers' self-efficacy beliefs regarding technology use?
    c) What is the impact of PBL on pre-service teachers' beliefs about the instructional value of computers?
2. How do preservice teachers' intended teaching practices change after participation in a PBL approach to technology integration?
3. What are preservice teachers' perceptions of the PBL experience?

Methods

This study used a mixed method approach to analyze the impact of PBL on preservice teachers' beliefs regarding technology use. First, we measured changes in teachers' beliefs regarding technology use. The teachers' beliefs survey was composed of three components: teachers' pedagogical beliefs, teachers' self-efficacy beliefs about computer use, and teachers' beliefs about the perceived value of computers for instructional purposes.

Second, pre-and post-course lesson plans were used to measure changes in students' intended teaching practices after participation in a technology integration course based on PBL. Participants' intended teaching practices were analyzed with a lesson plan rubric.

Third, course reflections and end of term interviews were used to investigate students' perceptions of the PBL experience. Guided questionnaires were used for both reflections and interviews.

Participants and Course

Fifty-five preservice students, enrolled in four sections of a one-credit educational technology course, participated during spring 2005. This one-credit course was designed to help students achieve a greater understanding of issues and techniques related to integrating educational technology in K-12 settings through hands-on activities and discussion. The course met once a week, for two hours, over the first eight weeks of the semester.

All the information provided by participants was kept confidential, and a unique coding system using section numbers and initials was used to track students' pre- and post-survey data, pre-and post-course lesson plans, reflections and interviews. The institutional review board deemed the study exempt under human subjects guidelines.

Procedures

The first class started with two digital video clips presenting interviews of school administrators including a middle school principal and a school superintendent. These video clips introduced the problem situation: the school district needed to hire competitive new teachers who could integrate technology into their classrooms.

In the first week, students watched both digital video clips through the course website and then formed small groups of 3 or 4 students, according to their major area of study. Each group "created" a teacher candidate to apply for the new teacher position, including the development of a web-portfolio.

In the second week, each student submitted a lesson plan, which included the use of technology, following specific guidelines that required them to describe learners, goals, assessment methods, resources, and so on. Early lesson plans were compared with lesson plans developed at the end of the course to examine how students' intentions to use technology changed over the course.

During the course, each group gathered additional information about technology integration and watched sample digital video cases of technology being integrated into K-12 classrooms. After watching the digital video cases, students discussed strengths and weaknesses of teachers' technology practices. In addition, students submitted their reflections focusing on the PBL process at the end of weeks 3 and 8.

As a capstone requirement, each group created a digital portfolio, using the artifacts created during the term to apply for the new teacher positions available in the school district. There were three main artifacts in the web portfolio: 1) an artifact to show the candidate's skills (e.g., digital curriculum vitae) 2) an artifact to demonstrate the candidate's knowledge (e.g., lesson plans integrating technology, video teaching demonstration), and 3) an artifact to show the candidate's attitudes (e.g., an essay of teaching philosophy). Each group made 20-minute presentations to the middle school principal and the superintendent, as a way of applying for the available positions.

Data Sources

Data sources included a survey of teachers' beliefs regarding technology use, lesson plans, students' reflections, and interviews. The survey was completed at the beginning and at the end of the term. Students' reflections were collected at the end of weeks 3 and 8. Interviews were conducted with five participants after the course ended. Each data source is described in more detail below.

1) Teachers' Beliefs regarding Technology Use Survey (TBTUS)

In this study, teachers' beliefs regarding technology use were measured by examining three aspects of teachers' beliefs: teachers' beliefs about student-centered learning, teachers' efficacy for technology integration, and teachers' perceived value for computers in teaching and learning (Chen, Burnam, Howie, Aten & Nambiar, 2003; Ertmer et al., 2003; McCombs & Lauer, 1997; McKenzie, 2002).

The *Teachers' Beliefs Regarding Technology Use Survey* (TBTUS) contains 54 items including 35 items measuring teachers' beliefs about student-centered learning, 7 items measuring teachers' self-efficacy for technology integration, and 12 items measuring teachers' perceived value for computers in teaching and learning (see Appendix A). Each component is described below.

a) Teachers' beliefs about student-centered learning

This survey was developed as a part of the Assessment of Learner-Centered Practice (ALCP) and has been tested over the past 4 years. One hundred fifty seven college instructors and 2,558 college students representing 12 institutions and 10 states, participated in the field testing and initial validation (McCombs, 2002).

The survey has 35 items (see Appendix A, items 1~35) divided into three sub-scales: Learner-centered beliefs about learners, learning, and teaching (14 items), non learner-centered beliefs about learners (9 items), and non learner-centered beliefs about learning and teaching (12 items). The Cronbach alpha reliability coefficient for each sub-scale ranged from .87 to 82. Learner-centered beliefs was .87, non learner-centered beliefs about learners was .83 and non learner-centered beliefs about learning and teaching was .82 (McCombs & Lauer, 1997).

In this survey participants rate their levels of agreement on a 4-point Likert scale, from strongly disagree (1) to strongly agree (4) (e.g., "Students have more respect for teachers they see and relate to as real people, not just as teachers." "Knowledge of the subject area is the most important part of being an effective teacher." "I am

confident that I can use technology as an effective teaching tool." "I am confident that I can meet the challenges of technology integration." "My students can learn problem-solving more effectively with computers." "I expect students to organize their thinking using Inspiration and other software program to make mind maps.").

A pilot study conducted fall 2003 (Park et al., 2005) showed a Cronbach alpha reliability coefficient for each sub-scale from .73 to .88. Learner-centered beliefs about teaching, learning, and learners was .88, non learner-centered beliefs about learners was .75, and non learner-centered beliefs about teaching was .73. Bai (2006) recently used this same survey with 230 students to examine teachers' pedagogical beliefs. The results of her factor analysis indicated the same three factors as McCombs and Lauer (1997).

b) Teachers' self-efficacy beliefs regarding technology use

A recent study (Ertmer et al., 2003) used a seven-item survey, *Teachers' Self-Efficacy for Technology Integration*, to measure pre-service teachers' self-efficacy for integrating technology (see Appendix A, items 36-42). Its reliability coefficient using Cronbach's alpha was .89, suggesting that the instrument was highly reliable. In addition, the items were evaluated by an expert in the area of self-efficacy and modified based on his suggestions, providing the instrument with content validity. The Cronbach alpha for this part of the teachers' beliefs survey was .94 in the pilot study (Park et al., 2005).

c) Teachers' beliefs about the perceived value of computers

It is difficult to find a survey related to teachers' perceived value of computers for teaching and learning, although, surveys related to teachers' attitudes toward computers are common. Therefore, 12 items relevant to teachers' perceived value for computers for instructional use were selected from the surveys employed by practitioners in the fields (Chen et al., 2003; McKenzie, 2002). The items were evaluated by an expert in the area of technology integration for pre-service education and modified based on her suggestions, providing the instrument with a measure of face validity. The Cronbach alpha for this part of the teachers' beliefs survey was .88 in the pilot study (Park et al., 2005).

2) Lesson Plans

Participants turned in lesson plans both at the beginning of the course and at the end of the course and their lesson plans were graded according to a lesson plan rubric (see Appendix B). The rubric was composed of 7 categories: 1) teachers' roles, 2) students' roles, 3) curricular characteristics, 4) learning goals, 5) types of activities, 6) assessment strategies, and 7) types of technology.

Pre-and post-course lesson plans (86 lesson plans) were analyzed by two independent graders using the lesson plan rubric and scored on each category according to a scale (where 1 = teacher-centered learning and 4 = student-centered learning). Scores for each category were summed to get a total score. The lowest score possible was 7 and the highest score possible was 28. The two graders graded the same 26 lesson plans (30% of all the lesson plans) and discussed discrepancies following guidelines of inter-rater reliability (Stemler, 2004). After the two graders reaching an agreement on using the rubric with these 26 lesson plans, each grader graded 30 lesson plans individually. The graders were blind as to whether the lesson plan was from the beginning or end of the course. They reached consensus with 94.86% agreement. The result of this analysis was examined to determine changes in preservice teachers' intended teaching practices to use technology.

3) Reflections and Interview

To investigate preservice teachers' perceptions of the PBL experience over the semester, students' reflections were collected and five student interviews were conducted. Guided questionnaires were provided to collect students' course reflections in weeks 3 and 8 (e.g., "What was impressive in the class?" "What do you feel could be improved in the class?"). A semi-structured interview questionnaire was used to interview students after the course (e.g., "Could you describe your experiences of group work during the course?" "Could you explain how you changed your beliefs about technology use after the course?"). Reflections were collected from all the students who enrolled in the course and five students volunteered to be interviewed.

Results

Q1. What is the impact of problem-based learning on preservice teachers' beliefs regarding technology use?

Among 55 preservice teachers enrolled in the course, 43 preservice teachers completed both the pre- and post survey and lesson plans. The data from the *Teachers' Beliefs regarding Technology Use Survey* were used to determine the impact of PBL on teachers' beliefs regarding technology use. A paired t-test ($df = 42$) indicated a significant increase in preservice teachers' self-efficacy beliefs regarding technology use ($t = 2.31$; $p < .05$) from pre- to post survey while there were no significant changes in preservice teachers' pedagogical beliefs and preservice teachers' beliefs about the instructional value of computers.

Q2. How do preservice teachers' intended teaching practices change after participation in a PBL approach to technology integration?

Data from the pre- and post-course lesson plans were analyzed using a rubric developed for this purpose. A paired t-test ($df = 42$) showed a significant change in preservice teachers' intended teaching practices ($t = 2.14$; $p < .05$) after participation in a PBL approach to technology integration. Preservice teachers' scores increased from a pre-course lesson plan mean of 15.16 (*SD*=6.85) to a post-course mean of 17.16 (*SD*=7.14). In general, preservice teachers tended to change their intended teaching practices from teacher-directed learning to student-centered learning.

Specifically, the changes in the following two categories in the rubric significantly changed toward student-centered learning: "types of technology use" ($t = 3.15$; $p < .01$) and "curriculum characteristics" ($t = 1.97$; p =.05). For example, in the pre-course lesson plan, one student described how he/she would use PowerPoint and an LCD projector to deliver a lecture: "Because I seemed to learn well with this style in high school and college…I believe lecturing in front of the class is the most useful method."

However, in the post-lesson plan, a greater variety of technology was used to help students' learning. For example, some participants used technology to provide authentic examples through 3D models, hands-on experiences with simulation websites, and other useful resources for research. In addition, the number of activities involving group work and discussion increased, which does not necessarily translate into a student-centered approach but suggests that students were considering the use of activities that allowed the students to be more active.

Q3. What are preservice teachers' perceptions of the PBL experience?

Preservice teachers' reflections and interviews were analyzed to examine their perceptions about PBL experience. Although there were some suggestions for improving the course, reflections and interview comments were overwhelmingly positive. Preservice teachers liked having an authentic problem situation that helped them establish their own goals and provided opportunities to practice technology integration. Overall, preservice teachers perceived that the most effective aspects of the process included the group work, class discussions, and being able to contribute their own ideas. Preservice teachers enjoyed being able to share their ideas and to hear different perspectives. Following are a few representative statements from preservice teachers' reflections and interviews:

> With the group work, I really liked that because I think you can learn from each other with problem-based learning. And if I didn't have any ideas and I didn't have an idea of answers, somebody else had ideas about it. It helped a lot. We could really help each other a lot.
>
> One thing that I found to work well was that the entire class was based mostly on discussions among students. Hearing other's points of views opened your own to new things and we were able to feed off one another.
>
> This class wasn't really like any of other ones I've taken since I've gotten to college. This class made me think on my own and use my own ideas to do major projects.

Discussion and Implications

The results of this study indicated that preservice teachers who participated in a PBL approach to learning about technology integration significantly increased their self-efficacy beliefs regarding technology use. In addition, the participants in this study significantly changed their intended teaching practices, specifically related to technology use, from teacher-directed to student-centered after participating in the PBL approach. Furthermore,

reflections and interviews supported the idea that preservice teachers benefited from the PBL approach and perceived positive impacts from group work, class discussion, and being able to provide input during the process.

The survey results did not show any changes in pedagogical beliefs or in the perceived instructional value of computers from pre- to post-course. As many researchers have pointed out, preservice teachers' beliefs are persistent and difficult to modify; preservice teachers bring a set of beliefs with them to teacher education programs, based on their own experiences as learners (Kennedy, 1997; Richardson, 2003).

Nevertheless, some initial movement was shown in the way preservice teachers thought about their own teaching as represented by their lesson plans. This result supports findings by Derry and her colleagues (2002) that suggested that preservice teachers' beliefs can be changed through authentic experiences and hands-on activities. It may be assumed that the hands-on activities with a variety of software and visible course products can affect the result. That is, preservice teachers could see distinctive changes and improvement of their skills, knowledge, and attitudes regarding technology integration through hands-on experiences and artifact development. In other words, it is easier to see the evidence of increased ability regarding technology skills through artifacts and it can affect self-efficacy beliefs regarding technology integration significantly. However, it is difficult to see evidence of changes in one's pedagogical beliefs and beliefs about the instructional value of computers.

The preservice teachers in this study perceived the PBL experience, particularly the use of group work and class discussion, to be a positive aspect of PBL. Pedersen and Liu (2003) suggested that collaboration is needed in the teacher education program and emphasized its potential impact on learning beyond the development of social skills.

From an instructor's perspective, a PBL approach may positively impact preservice teachers' beliefs regarding technology use. Furthermore, this type of approach may help preservice teachers move their intended teaching practices toward student-centered learning as well as provide opportunities to practice skills, gain knowledge, and develop positive attitudes about technology integration. Although it is difficult to change preservice teachers' beliefs radically through PBL, this study could be viewed as a beginning point to changing beliefs regarding technology use. Further investigation is planned, and the result of these investigations hopefully will help other teacher educators to develop and implement effective technology integration programs for preservice teachers.

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Appendix A
Teachers' Beliefs Survey Regarding Technology Use

Please read each of the following statements. Then decide the extent to which you agree or disagree. Circle the number to the right of the question that best matches your choice. Go with your first judgment and do not spend much time mulling over any one statement. PLEASE ANSWER EVERY QUESTION.

		Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
1	Students have more respect for teachers they see and can relate to as real people, not just as teachers.	1	2	3	4
2	There are some students whose personal lives are so dysfunctional that they simply do not have the capability to learn.	1	2	3	4
3	I can't allow myself to make mistakes with my students.	1	2	3	4
4	Students achieve more in classes in which teachers encourage them to express their personal beliefs and feelings.	1	2	3	4
5	Too many students expect to be coddled in school.	1	2	3	4
6	If students are not doing well, they need to go back to the basics and do more drill and skill development.	1	2	3	4
7	In order to maximize learning, I need to help students feel comfortable in discussing their feelings and beliefs.	1	2	3	4
8	It's impossible to work with students who refuse to learn.	1	2	3	4
9	No matter how bad a teacher feels, he or she has a responsibility not to let students know about those feelings.	1	2	3	4
10	Addressing students' social, emotional, and physical needs is just as important to learning as meeting their intellectual needs.	1	2	3	4
11	Even with feedback, some students just can't figure out their mistakes.	1	2	3	4
12	My most important job as a teacher is to help students meet well-established standards of what it takes to succeed.	1	2	3	4
13	Taking the time to create caring relationships with my students is the most important element for student achievement.	1	2	3	4
14	I can't help feeling upset and inadequate when dealing with difficult students.	1	2	3	4
15	If I don't prompt and provide direction for student questions, student won't get the right answer.	1	2	3	4
16	Helping students understand how their beliefs about themselves influence learning is as important as working on their academic skills.	1	2	3	4
17	It's just too late to help some students.	1	2	3	4
18	Knowing my subject matter really well is the most important contribution I can make to student learning.	1	2	3	4
19	I can help students who are uninterested in learning get in touch with their natural motivation to learn.	1	2	3	4
20	No matter what I do or how hard I try, there are some students who are unreachable.	1	2	3	4
21	Knowledge of the subject area is the most important part of being an effective teacher.	1	2	3	4
22	Students will be more motivated to learn if teachers get to know them at a personal level.	1	2	3	4

		Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
23	Innate ability is fairly fixed and some children just can't learn as well as others.	1	2	3	4
24	One of the most important things I can teach students is how to follow rules and to do what is expected of them in the classroom.	1	2	3	4
25	When teachers are relaxed comfortable with themselves, they have access to a natural wisdom for dealing with even the most difficult classroom situations.	1	2	3	4
26	Teachers shouldn't be expected to work with students who consistently cause problems in class.	1	2	3	4
27	Good teachers always know more than their students.	1	2	3	4
28	Being willing to share who I am as a person with my students facilitates learning more than being an authority figure.	1	2	3	4
29	I know best what students need to know and what's important; students should take my word that something will be relevant to them.	1	2	3	4
30	My acceptance of myself as a person is more central to my classroom effectiveness of my teaching skills.	1	2	3	4
31	For effective learning to occur, I need to be in control of the direction of learning.	1	2	3	4
32	Accepting students where they are no matter what their behavior and academic performance-makes them more receptive to learning.	1	2	3	4
33	I am responsible for what students learn and how they learn.	1	2	3	4
34	Seeing things from the students' point of view is the key to their good performance in school.	1	2	3	4
35	I believe that just listening to students in a caring way helps them solve their own problems.	1	2	3	4
36	I am confident that I can use technology as an effective teaching tool.	1	2	3	4
37	I am confident that I can use one computer effectively during large group instruction.	1	2	3	4
38	I am confident that I can develop effective lessons that incorporate technology.	1	2	3	4
39	I am confident that I can use technology effectively to teach content across the curriculum.	1	2	3	4
40	I am confident that I can overcome difficulties using technology in the classroom (time, scheduling, accountability).	1	2	3	4
41	I am confident that I can manage the grouping of students while using technology as a teaching tool.	1	2	3	4
42	I am confident that I can meet the challenges of technology integration.	1	2	3	4
43	Computers can provide instruction suited to individual students' needs.	1	2	3	4
44	Computer use promotes student-centered learning and self-discovery.	1	2	3	4
45	Computers can enhance my students' creativity and imagination.	1	2	3	4
46	Computers can engage my students in collaborative work.	1	2	3	4

		Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
47	My students can learn problem-solving more effectively with computers.	1	2	3	4
48	Writing is easier for my students when they use computers.	1	2	3	4
49	I encourage and model smart choices about the tools students might use to accomplish tasks, using books, a spreadsheet or digital information when each one is the best.	1	2	3	4
50	I encourage students to use the Internet and e-mail to communicate with experts, other students and people from around the world to enrich their learning.	1	2	3	4
51	I expect students to organize their thinking using Inspiration and other software program to make mind maps.	1	2	3	4
52	I ask students to use networked computers to explore important questions and issues arising out of the content of my class.	1	2	3	4
53	I am making more time now than I used to for students to do more of the thinking, analyzing, interpreting, inferring, and synthesizing of information.	1	2	3	4
54	I am getting quite good at recognizing worthy uses of new technologies while avoiding the silly, trendy uses that waste time without delivering much of value.	1	2	3	4

Appendix B

Lesson Plan Rubric

	Directed (Level 1: point 1)	Mixed but more toward directed (Level 2: point 2)	Mixed but more toward constructivist (Level 3:point 3)	Constructivist (Level 4: point 4)
1. Teacher roles(teacher's activity)	Transmitter of knowledge; expert source; director of skill/concept development through structured experiences	Mixed role of lecturer and facilitator but more toward to directed (i.e., prepare only single resource)	Mixed role of lecturer and facilitator but more toward to constructivist (i.e., prepare various resources)	Guide and facilitator as students generate their own knowledge; collaborative resource and assistant as students explore topics
2. Student roles(Student activity)	Receive information; demonstrate competence; all students learn same material and complete same activities	Mixed role of receiver of content and active learner through collaboration but more toward to directed (i.e., more passive way following teachers' structured instruction)	Mixed role of receiver of content and active learner through collaboration but toward to constructivist (i.e., more active way to engage in different activities)	Collaborate with other; develop competence; students may learn different material or engage in different activities
3. Curriculum characteristics	Based on skill and knowledge hierarchies; skills taught one after the other in set sequence	Mixed methods but more toward to directed and follow more hierarchies	Mixed methods toward to constructivist and more holistic approach	Based on projects that foster both higher level and lower level skills concurrently
4. Learning goals	-Stated in terms of mastery learning and behavioral competence in a scope and sequence (clearly stated skill objectives with test items matched to them) -Teacher-selected goals	Mixed goals with mastery knowledge/skills and construction of knowledge but more toward to directed (e.g., following more sequenced knowledge/skills)	Mixed goals with mastery knowledge/skills and construction of knowledge but more toward to constructivist (e.g., more self-directed and their own research based goal)	-Stated in terms of growth from where student began and increased ability to work independently and with others (global goals that specify general abilities like problem-solving and research skills) -Student-selected goals and self-directed learning

5. Types of activities	Lecture, demonstration, discussions, student practice, seatwork, testing	Mixed activities of individual work and group work either with hands-on or without hands-on activities (i.e, more towards individual work, either hands-on or group work)	Mixed activities of individual work and group work either with hands-on or without hands-on activities (i.e, use both group work and hands-on activities; use either hands-on or group work more toward constructivist)	Group projects, hands-on exploration, product development, problem solving activities with flexibility in grouping
6. Assessment strategies	Written tests and development of products matched to objectives ; all tests and products match set criteria; same measures for all students	Mixed assessment with both written test and performance test but more toward to directed	Mixed assessment with both written test and performance test but more toward to constructivist	Performance tests and products such as portfolios; quality measured by rubrics and checklists; measures may differ among students
7. Types of technology use	Evident technology use based on teacher-centered learning (e.g., using drill-practice s/w, use single media to deliver lecture)	Mixed technology use based on both teacher-centered and student-centered learning but more toward to directed (i.e. use tutorial style or information driven s/w, combine more lecture and technology use is more for teacher-centered and less student-centered)	Mixed technology use based on both teacher-centered and student-centered learning but more toward to constructivist (i.e. combine less lecture and use multiple media, single media for constructivist way for more student-centered)	Evident technology use based on student-centered learning (i.e., problem solving method)

Attrition In Distance Education: A Meta-Analysis

Deborah A. Storrings
Syracuse University

Abstract

This meta-analysis reviews twenty years of research on the effect of attrition predictor variables on distance education post-secondary learners. The predictor variables were derived from a series of attrition models, theories, and studies, and then further identified, defined, and grouped for additional analysis to determine their specific effect on attrition. Thirty studies on distance education attrition met the criteria for inclusion in this meta-analysis. There were seven moderator variables coded for each of 30 studies producing 284 separate (k=284) effects. The overall effect size was 0.059, concluding there is no significant pattern in identifying variables that cause or contribute to distance education attrition within the empirical literature reviewed.

Index words: Distance Education, Attrition, Completion, Persistence, Retention, Meta-Analysis, Effect Size

Introduction

Attrition has been a longstanding problem for almost all higher education institutions, and it is even more so with distance education seeing even higher rates (Carr, 2000; Holmberg, 1986; Parker, 2003). Carr states that attrition in distance education is not a recent discovery and while several research studies have addressed the subject, they have for the most part, all taken a different perspective on the issue.

To date, there have been a number of wide-ranging studies that have been conducted to explore a variety of these predictor variables. For example, there are studies examining instructional design (Chyung, 2001; Van Schaik, Barker, & Beckstrand, 2003), demographics (Despain, 2003; Eisenberg & Dowsett, 1990; Frew & Weber, 1995), community engagement (Pugliese, 1994), program satisfaction (Schell & Thornton, 1985), and feedback and turnaround time (Taylor et al., 1986), to name just a few. There have also been a number of research studies that have tried to adopt many of the constructs outlined in Tinto's (1975) retention model. These studies tried either to validate Tinto's model, modify it, or create a new model or theory based on it, with varying levels of success (Bernard & Amunden, 1989; Fjortoft, 1995; Kember, Murphy, Siaw, & Yuen, 1991; Pugliese, 1994; Sweet, 1986). Finally, there are a number of studies that employed an experimental design to evaluate a single variable. For example, Frith and Kee (1994) used a control and treatment design to look specifically at the effect of differing communication methods, or Waschull (2001) who examined outcomes related to attrition based on mode of delivery.

Understanding these studies and their numerous constructs is problematic since each study uses different sets of variables and different types of statistical analysis to predict attrition. Given these many different approaches to examining attrition in post-secondary distance education, it is not surprising that the findings in the research have been mixed at best.

A review of the literature also indicated a lack of consensus on how many and what should be considered a valuable predictor variable. Kember (1989) notes, "The attrition process is undoubtedly a complex one, a theory that could fully explain every aspect of the attrition process would contain so many constructs that it would become unwieldy if not unmanageable" (p. 279). Therefore, this study conducted a meta-analysis to identify the overall effect of attrition in distance education, and to investigate possible sources of variation among the predictor variables that may explain the diverse findings within the literature on distance education attrition. This quantitative synthesis investigated following questions:

1. What is the average effect size over distance education attrition studies, and is it different from zero?
2. Is the effect size related to study characteristics, and if so, do they have a positive or negative affect on attrition in distance education?
3. Were effect sizes influenced differentially by methodological characteristics?
4. Were effect sizes influenced differentially by substantive characteristics?

To answer these questions, this study synthesized peer-reviewed thirty research studies on attrition in distance education. The study employed the research method of meta-analysis based on the works of Glass, McGaw and Smith (1981), Orwin (1983), Hedges and Olkin (1985), Mullen (1989), Rosenthal (1979; 1991), and Lipsey and Wilson (2001).

Review of Literature

The review of the literature began with an examination 20 years of quantitative studies to analyze the phenomenon of attrition in post-secondary education, specifically distance education. The review started with Vincent Tinto's 1975 higher education predictive retention model, which is known to be one of the most extensively cited and the most widely tested models to date (Kember, 1989). Tinto's model was designed to address traditional four-year university students in a face-to-face arena. However, this model has also been cited in numerous studies (Kember, 1989; Sweet, 1986; Smith, 2001; Taylor et al., 1986) related to distance education and has been used to launch many new and diverse attrition theories, models, and studies. Tinto's model concluded that a student's commitment to college, and his or her personal academic goals and background, have a direct impact on their persistence. Tinto claims that based on how well a student integrates into the scholastic and social systems of the institution will be determined whether or not they dropout. In 1983, Pascarella and Chapman's research on attrition also concluded that a student's interaction with college life was connected to retention, further supporting Tinto's claim (Halpin, 1990; Pascarella & Chapman, 1983; Pascarella & Terenzini, 1998; Terenzini & Pascarella; 1980).

In later years, Tinto realized the narrow scope of his model and in his 1982 article entitled, "Limits of theory and practice in student attrition", he stated that if his earlier model were to be used for nontraditional forms of education such as distance education, then modification would be required. David Kember (1989) did just that by taking Tinto's model and redesigning it for use with distance education students. Kember illustrated that distance education students were most often part-time and older than those who studied on campus, and for this reason factors other than college life and academic integration weighed more prominently in their decision to drop out. In his research on attrition, Kember developed the Distance Education Student Progress inventory (DESP). With this instrument, he concluded that a number of external variables such as employment and family obligations played a strong role in the attrition of distance education students. Further, Kember pointed out that looking at single variables is of little value and argued that the examination, use of, and integration of multiple variables would enhance the successful prediction of attrition. Kember's continued research in 1990 concluded that intrinsic motivation was a strong predictor of retention, especially when students perceived their educational experience was significant to their job or personal interests.

Kember's research was confirmed when Fjortoft (1995) experimented with a model designed to predict adult student attrition in distance education. Fjortoft concluded an adult student was less likely to drop out if he or she expected to gain "tangible career related results" (Fjortoft, 1995, p. 2). Fjortoft identified five variables that could be used to predict attrition among adult learners in a professional distance education program; age, previous college education, intrinsic job satisfaction, attitude towards learning, and perceived benefits of completion.

An alternative model researching the nontraditional student, still based on Tinto's framework, was Bean's 1980 Causal Model of Student Attrition. This model investigated the "student's institutional fit" (Rovai, 2003, p.3) by using the student's personal characteristics (demographics) and his or her academic backgrounds as variables for determination. Bean argued that students dropped out for the same reasons that employees left their jobs, including factors such as relocation and better opportunity. In 1985, Bean worked with Metzner on a new, more refined model for nontraditional students, which defined four variable sets that could predict attrition: background variables, environmental variables, academic variables, and intent to leave (Bean & Metzner, 1985). Bean and Metzner's model was one of the first to argue that external variables such as hours of employment, family obligations, and personal finances played a major role in predicting attrition for nontraditional students.

In 1988, Bean's work was modified by Billings who developed an attrition model centered around four variable sets to predict attrition. Two of the four variable sets closely paralleled Bean's and Tinto's academic performance and environment variables. Billings argued that the other two variable sets that predict attrition for student parting in correspondence course are supporting structure and course variables (Billings, 1988).

Each study reviewed has its own constructs similar to Billings, sometimes building off someone else's variable(s), sometimes redefining those same variable(s), and other times just manufacturing their own. For example, Sweet (1986) found that perceived helpfulness of faculty and non-course discussions with instructors were variables that could predict attrition accurately. Pugliese (1994) found that psychological factors such as loneliness, communication apprehension, and locus of control were not valid predictor variables of attrition for distance education students. Pugliese did conclude that distance education "appears to be a social equalizer when it comes to

receiving course credits" (p. 34). Taylor et al. (1986) found that quick turnaround time on correspondence and review of assignments could be positively correlated to retention. Contrary to several models that suggest past education is a significant attrition predictor, Chacon-Duque (1985) concluded that past academic experience and age were not valid predictors, but variables such as quality of course materials, variety of media, and planned student support were exceedingly significant indicators.

From the literature, two distinctions of the status of research on student attrition in distance education were evident. First, there seems to be no variable set(s) that is defined in the same way, nor are there any theories or models that appear to rise above the rest. Tinto's model does emerge as a basic building block for most other theories and models, including those developed for nontraditional students and for distance education. However, each researcher tends to interpret or modify Tinto's variable sets in his or her own manner, while others continue to create new and more encompassing variable sets, hence increasing the complexity of attrition predictor variables.

Second, the research seems to be going in many different directions simultaneously while also producing a high number of contradictory reports. There were for example a number of studies that validate the significance of a preceding study but then argue that the past findings need to be altered by either deleting a variable set(s) or by including a new or modified variable set(s). Conversely, immediately after a research study identifies a new variable set(s), it is directly followed-up by another study suggesting an opposite conclusion. This is partially because many studies look at unique populations or use a different way in which to define and calculate attrition. In view of all these variations in the literature on this topic, it would currently be difficult to decide on any type of implementation strategy to prevent attrition in distance education.

Method

Inclusion Criteria

All studies used in this meta-analysis had to meet the following inclusion criteria throughout all stages of the literature search:

1. Studies must incorporate attrition rates or data for post-secondary students partaking in distance education.
2. Studies must have sufficient descriptions of population characteristics.
3. Studies need to have been published in an English-language peer-reviewed journal or English-language dissertations, ensuring that the quality of the study meets research standards in the field.
4. Studies published before 1984 will not be included in order to provide for a more contemporary database.
5. Studies must contain statistical documentation to allow for calculation or estimation of effect size.

Literature Search Methods

The first round of searching consisted of a systematic scan of the following databases: Education Resources Information Center (ERIC), PsycINFO, Education Abstracts, Social Science Abstracts, and Dissertation Abstracts. The computer search strategy used the following keyword search terms: attrition, dropout, non-completer, non-persister, withdrawal, distance, online, distributive, web-based, computer based, and correspondence education and training. This preliminary round of database searches produced 104 articles and 75 dissertation abstracts. Of these only 27 articles and 61 dissertations meet all of the inclusion criteria. Many of those eliminated were qualitative studies or case studies that included no statistical information. A number of others were eliminated because they met most but not all of the inclusion criteria. For instance, some researched secondary school attrition or others used a single group non-experimental design.

Most of the remaining 89 candidates only survived because their abstracts were not specific enough to exclude them without further investigation. After gathering full copies of each study, the field was further reduced to nine articles and twenty dissertations. A second round of inquiry was performed by searching individual journals that were identified through the primary search and finally an ancestral search was completed. These additional searches produced three more dissertations for a total of nine articles and twenty-one dissertations.

Coding

Studies were coded into moderator variables that fell into two categories, substantive and methodological. There were four substantive variables; study focus, institution type, student type, and attrition factors and three methodological variables: statistics reported, article type, and publication year. Each is these was further broken down as outlined in Table 1.

Table 1. - Coding Scheme

Substantive		Score
Institution Type		
	Traditional 4 year	1.1
	Community/Junior/Tech College	1.2
	Open University	1.3
	Corporate Training and Continuing Education	1.4
Student Type		
	Traditional 18-24	2.1
	Graduate/Post Bachelors	2.2
	Professional or Life Long Learner	2.3
Study Focus		
	Course Attrition	3.1
	Program Attrition	3.2
Attrition Factors		
	Demographic	4.1
	External	4.2
	Internal	4.3
	Mixed	4.4
Methodological		
Publication Year		
	1984-1994	5.1
	1995-2004	5.2
Source Type		
	Peer-reviewed Journal	6.1
	Doctoral Dissertation	6.2
Research Method		
	Mean and Standard Deviations	7.1
	F, t, r, X^2	7.2
	Odds ratio\2x2 tables	7.3
	Mixed	7.4

Before beginning the meta-analysis statistical procedure, an inter-rater reliability analysis was performed on the coding scheme. The coding was performed by two independent researchers returning a Kappa score of .6825, falling into the substantial range.

Results

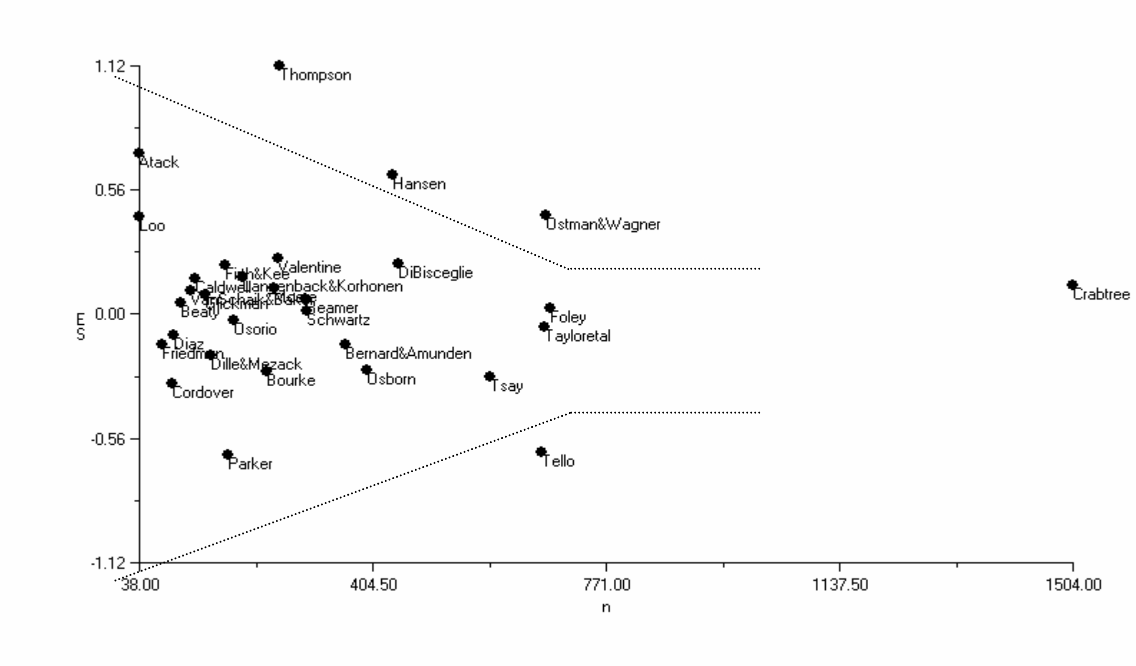
Characteristics of the Studies

Thirty studies on distance education attrition met the criteria for inclusion in this meta-analysis. Twenty-one were dissertations and nine were from peer-reviewed journals. The studies were published from 1989 to 2003, with the median year being 2000. Thirty-nine percent of the studies (n=12) fell into the early years coding category, those published from 1984 to 1994; the remaining 61 percent (n=18) were coded as later years, from 1995 to 2003. Sample sizes ranged from a low of 38 to a high of 1504 for an approximate 9769 participants, with a median of 252 participants per study. The majority of studies, 50 percent (n=15), examined distance education attrition at traditional four-year institutions; 27 percent (8) at community colleges; 17 percent (n=5) at open universities; and the remaining researched professional development and/or corporate training. Thirty-seven percent of the studies explored only internal attrition variables (n=11), including such items as assignment turnaround time, course materials, and amounts of faculty interaction. Twenty-seven percent analyzed only demographic attrition variables (8) such as age, past education, distance from the offering institution. The remaining 36 percent researched variables from all three variable sets (mixed), demographics, internal and external, while no studies focused exclusively on external attrition factors.

Publication bias, the file drawer, and normality

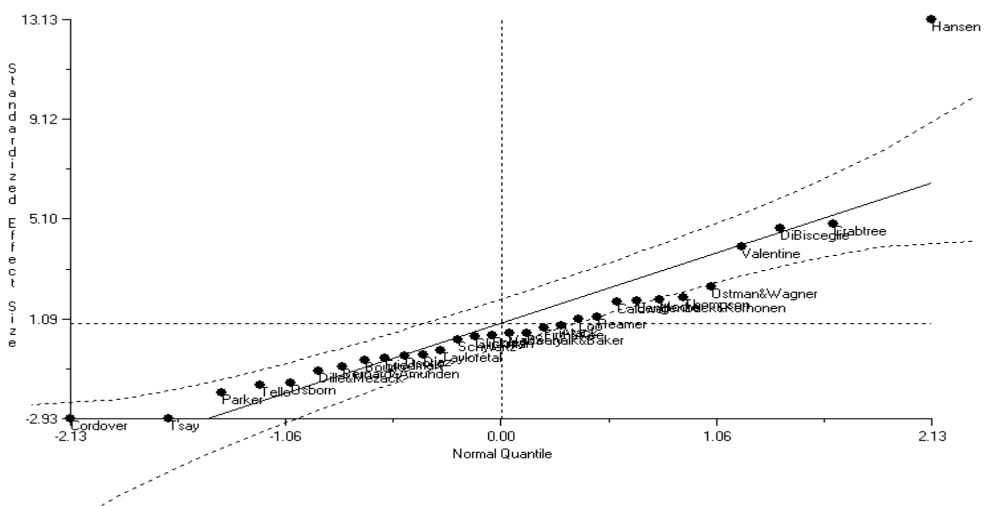
Publication bias was addressed by creating a funnel plot of effect size against their corresponding sample size (Light & Pillemer, 1984) as seen in Figure 1. There were two types of studies used in this meta-analysis, those selected from peer-reviewed published journals, and those from doctoral dissertations. Since the effect size calculated for both the published journal studies and the dissertations are relatively the same (journals d= 0.0609, dissertations d= 0.0569), it seems evident that no significant journal bias is present.

Figure 1 – Funnel Plot



To look further for publication bias and to assess normality, a normal quartile plot was created (Figure 2). All of the studies fall within 95 percent confidence interval with the exception of the Hansen dissertation, which had an effect size that was medium to large (.6299), while also having an extremely small variance (.0023). The Hansen study appears to be out of the normal population, which is consistent with the overall effect size results of d=.059.

Figure 2 – Normal Quartile Plot



Overall Effect size

Two models are generally used in meta-analysis; the *fixed effects model* and the *random effects model*. The fixed effects model assumes that all of the variability between effect sizes is due to sampling error or the luck of the draw. The random effects model suggests that the variability between effect sizes is due to sampling error plus differences in the population of effects. For example, other random differences between studies may include differences in procedures, settings, methods, and population grouping, all of which go beyond simple subject level sampling error (Lipsey & Wilson, 2001). "Thus the observed variability in sample estimates of effect size is partly due to the variability in the underlying population parameters and partly due to the sampling error of the estimator about the parameter value" (Hedges & Oklin, 1985, p. 191). A more obvious difference between the two models is that the fixed effects model tends in general to show larger confidence intervals as well as a more significant overall effect size, presenting a less conservative approach. Although all of the studies had distance education attrition as their dependent variable, there were more than one hundred different attrition factors, several diverse and unique treatments, and varying types of subject classification and grouping. More importantly, there were several different statistical methods used to calculate effect sizes between and within studies, therefore a random effects model approach was deemed appropriate (Rosenberg et al., 2000).

Using the random effects model, Table 2 shows the results of the meta-analysis. From the 30 studies there were 284 effects calculated (*k*=284). The median for *k* was four, with a maximum of fifty-eight and a minimum of one. The overall effect size of *d* is 0.059, which is considered to be a non-significant result as defined by Cohen (1988) and Lipsey (1990). Although the effect size is different from zero, it is not near enough to the .20 that would be considered a small but significant effect size.

Looking closer at the results in Table 2, the lowest effect size appears in the Cordover dissertation with -.3151, and the highest is the Thompson dissertation at 1.1206, with an overall median effect size of .062, which is extremely close to the overall study *d* of .059. There were eighteen studies showing a positive effect size indicating that the independent variable (demographic, external or internal) could indicate changes in or predict the dependent variable (distance education attrition), while the remaining twelve studies showed the opposite. The overall effect size was positive at d= 0.0590 with a variance of 0.0808 having a 95 percent confidence level between -0.0397 and 0.1577. A random (pseudo) resampling (999 times) was done to produce a bootstrapped 95% confidence interval of -0.0337 to 0.1517, which is extremely close to the sample's 95% confidence interval, again reinforcing the normality of the data. A homogeneity analysis produced a *Q* of 30.1341, *df* 29, with *p* equal to 0.4073. Since *Q* was not statistically significant at the .05 level, it can be logically assumed that the data in the sample sufficiently represent the population (homogenous).

The normality of the sample, its homogeneity, and the result of *d*= 0.059 gives empirical evidence that there are no attributable variables to identify distance education students who complete and those who attrite. There appears to be no clear pattern in identifying, classifying, or accounting for distance education attrition within the distance education empirical literature. This meta-analysis posed four primary questions. The first asked, "Is there an average effect size across the 30 studies and is it greater than zero?" The answer is yes, there is an effect size greater than zero, but it is not sizeable enough to be considered a significant finding, hence eliminating the need to address the next three research questions.

Table 2. - Random Model Meta-analysis results

Study	Year	n	Effect Size	Var	k	95% Confidence Lower	Upper
Atack	2001	39	0.7233	0.8130	4	-0.8701	2.3167
Beaty	1994	103	0.0522	0.0100	1	0.0326	0.0718
Bernard & Amunden	1989	361	-0.1337	0.0249	16	-0.1825	-0.0849
Bourke	1997	239	-0.2561	0.1958	2	-0.6399	0.1277
Caldwell	2003	126	0.1593	0.0081	2	0.1434	0.1752
Cordover	1996	89	-0.3151	0.0116	1	-0.3378	-0.2924
Crabtree	2000	1504	0.1295	0.0007	1	0.1281	0.1309
Diaz	2000	91*	-0.0932	0.0665	15	-0.2235	0.0371
DiBisceglie	2002	444	0.2271	0.0023	8	0.2226	0.2316
Dille & Mezack	1991	151	-0.1882	0.0335	3	-0.2539	-0.1225
Frith & Kee	1994	174	0.2230	0.0932	1	0.0403	0.4057

Foley	1993	684	0.0294	0.0051	2	0.0194	0.0394
Friedman	2003	75*	-0.1383	0.0773	7	-0.2898	0.0132
Glickman	2003	141	0.0887	0.0506	49	-0.0105	0.1879
Hansen	2000	435	0.6299	0.0023	1	0.6254	0.6344
Langenback & Korhonen	1988	400*	0.1675	0.0084	9	0.1510	0.1840
Loo	2003	38	0.4429	0.1708	2	0.1081	0.7777
Moore	2001	249	0.1196	0.0041	1	0.1116	0.1276
Osborn	2001	396	-0.2536	0.0294	15	-0.3112	-0.1960
Osorio	1987	187	-0.0303	0.0054	18	-0.0409	-0.0197
Ostman & Wagner	1987	676	0.4487	0.0360	4	0.3781	0.5193
Parker	1994	177	-0.6373	0.1167	1	-0.8660	-0.4086
Reamer	1990	298*	0.0726	0.0038	19	0.0652	0.0800
Schwartz	1999	302	0.0137	0.0033	1	0.0072	0.0202
Taylor et al	1986	674*	-0.0549	0.0998	12	-0.2505	0.1407
Tello	2002	669*	-0.6208	0.1574	5	-0.9293	-0.3123
Thompson	1999	258*	1.1206	0.3360	7	0.4621	1.7791
Tsay	1999	589*	-0.2836	0.0095	12	-0.3022	-0.2650
Valentine	1986	256	0.2515	0.0040	58	0.2437	0.2593
VanSchaik & Baker	2003	119	0.1078	0.0436	4	0.0223	0.1933
Overall			**0.0590**	**0.0808**	**284**	**-0.0397**	**0.1577**

* - Approximate n values

Discussion

The present synthesis summarizes research examining the relationship between distance education completers and non-completers. As seen throughout the literature review, there are many models, theories, and studies that suggest a specific variable or sets of variables that can account for or predict attrition in post-secondary distance education, but the outcome of this meta-analysis suggests the opposite. The overall result of an effect size of .059 indicates that there are no factor(s) strong enough to identify significant differences between distance education completers and non-completers. The result of this study supports Rovai's conclusion that, "There is no simple formula that ensures student persistence" (Rovai, 2003, p.12). Further, indifferent to the claims of a number of other researchers, this study suggests there is no single variable or set of variables that can clearly be attributed to the prediction of distance education attrition.

An important finding of the study that warrants discussion is the quality of the studies in the distance education literature, since this is of prime concern for all meta-analyses. It would have been beneficial to incorporate a greater number of studies in this meta-analysis, but unfortunately, there were a large majority of studies in the research base that were methodologically flawed in one way or another. As a whole, the studies seemed to lack methodological rigor, with many studies using non-equivalent comparison groups rather than true random assignment. Some studies were flawed by simple errors such as number reversal in tables or text, groups transposed, or contingency tables missing strategic information. There were also several studies where the *n* was reported inconsistently within the body of the article with no given explanation. Due to the poor quality of research in this area, a sizeable number of studies that initially appeared to meet the selection criteria were eventually eliminated.

This study 's findings support Phipps and Merisotis (1999) findings that were prepared for the American Federation of Teachers and the National Education Association suggesting "there is striking evidence of the fact that there is relative paucity of true, original research dedicated to explain or predict phenomena related to distance education" (p.13). Further, they suggested, "merely being published in a journal or a book, for example, does not guarantee the quality of the study or that it was reported accurately" (p.19). This meta-analysis can confirm there was no difference between peer-reviewed journal articles and doctoral dissertations, both producing low but equivalent effect sizes (d=.06 and d=.057, respectively). This suggests that there may be no difference in quality, at least between these two types of research reports.

Further, there was no difference between the two sets of publication years, 1984-1994, and 1995-2004. The synthesis of research covered a twenty-year span in which the delivery mechanisms for distance education have

changed considerably, as have the numbers and the characteristics of today's distance learners. The speed at which educational technology is changing and the ever-increasing percentages of the population partaking in such, leads to the view that the results of this synthesis may be somewhat historical and somewhat less generalizable in the distance education arena of today. Despite these obvious differences in technology for service delivery, this study showed only a minute difference between those studies originating between 1984 to 1994 (n=12, d=.067) and those from 1995 to 2004 (n=18, d=.059). This would indicate that technology does not play a significant role in distance education attrition, that it lies in other areas.

Research Implications

As identified in the findings of this synthesis, there is a need for improved research methods in distance education research. Phipps and Merisotis (1999) rejected the findings in Thomas Russell's 1999 *The No Significant Difference Phenomenon* because of the poor quality of distance education research. They criticized many of the articles, especially those pertaining to original research, for not controlling for extraneous variables, not using random assignment, and using questionable instruments that lacked validity and reliability for data collection. This meta-analysis seems to validate those criticisms, as seen by the small number of usable studies. Of the 88 studies that initially appeared to meet the selection criteria from the primary search, only 31 percent (n=27) survived the screening process.

The quality of educational research has recently become a hot topic among legislators as well as academics. Recently enacted federal legislation, including the No Child Left Behind Act (2001) and the Education Science Reform Act (2002) has raised demands for "scientifically based" educational research. There is an intense debate on what constitutes a scientific base for educational research (Eisenhart & Towne, 2003), but its ultimate goal seems to be to produce more accurate studies based on methodologically sound research design, solid measurement, and appropriate statistical analyses.

Another compelling implication of this meta-analysis is that it supports Kember's (1990) notion that "dropping-out from distance education is a complex phenomenon" (p. 11). The true complexity with attrition is visible in how each study used in this synthesis chose to define or not to define the term attrition itself. Ten of the studies that were included gave no clear definition of attrition while others made in-depth statements. Their descriptions, explanations, and classifications were extremely diverse in nature. For instance, Loo (2003) used a somewhat detailed explanation of attrition; "students who have registered in an online course, but did not meet the course requirements of a passing grade, and did not withdraw by the official drop date or received an "F" or "IF" for incomplete fail were considered drop outs" (p. 27). Conversely, Dille and Mezack (1991) merely stated that attrition is the number of withdrawals from the course during the semester. An even more simplistic definition came from Ostman and Wagner (1987) who narrated, "respondents decided for themselves whether or not they were dropouts" (p. 53). Clearly, these researchers have different conceptual ideas on how attrition should be defined and operationalized. Accordingly, a given student could be labeled a dropout in one study, and as a persister in another. These circumstances make it enormously difficult to find meaning in what is in many other ways a particularly diverse literature. It appears that achieving consensus regarding the definition to the term attrition would help clarify some of the obscurity found among and between attrition studies. As far back as 1978, Pantages and Creedon noted, "ideally, studies of attrition should incorporate…a definitive unambiguous operational definition of dropout" (p.56). This is not yet the case, since studies produced in the past five years still have the limitation of not producing or using a single clear definition of attrition.

Recommendations

The most noteworthy recommendation as a result of this study is the need for longitudinal studies. Almost all of the studies reviewed were a quick snapshot in time, with the largest percentage of studies researching attrition over only one or two semesters. This again goes back to the quality of research in the area. It would be expected that longitudinal studies might be missing from the doctoral dissertation group, but more should be found in articles published in peer-reviewed journals. The need for longitudinal studies is evident in that all educational research is unique and each institution, classroom, or student may vary significantly from place to place, hence the accumulation of research evidence over time and across studies (meta-analysis) may be the best way to produce consistent and accurate findings (Waxman, Lin & Micko, 2003).

There are still many unanswered questions about distance education attrition, but research can play a key role in finding answers and solutions. The result of this research recommends not only the need for an accepted definition of distance education attrition, but the need for research studies that employ better measurement tools,

more pre-tested data collection instruments, and more detailed statistical analysis. Research studies in education need to focus on better design and more control for extraneous variables, so that the justification for study findings is stronger and defendable.

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Experiences versus Preferences for Online Interactions

Bude Su
Curt Bonk
Richard Magjuka

Abstract

In the current study, researchers examined learner experiences and preferences for a number of instructional activities that promote learner-instructor, learner-learner, and learner-self interactions in online learning environment. Statistical procedures were used to determine the discrepancies between learner experiences and preferences for these instructional activities. The follow up interviews further explained why certain instructional activities were less preferred while they were frequently used in practice. Results of this study have meaningful contribution to current practice of distance education.

Introduction

Although literature shows the importance of interactions for quality distance education, interaction seems lacking in many online courses (El-Tigi & Branch, 1997; McGorry, 2002). Instructor unfamiliarity with technology seems to be one of the key reasons why they do not know how to enhance online interactions in practice (Stenhoff et al., 2001). A study from the National Center for Education Statistics (2001) concurs on this point. It reports that one of the greatest challenges of teaching online is the lack of guidance on how to teach with new technologies. This is often because the skills required for teaching online are quite different from skills required for face-to-face teaching (Daniel, 2003; Shutt, 2003). Therefore, the fundamental issues of teaching online are not limited to the issues of technology; actually they are pedagogical in nature (King & Doerfertl, 1996; Oswald, 2003). It seems obvious that online instructors should re-examine the original assumptions and teaching methods in order to provide rich learning experiences to online learners. As part of this concern about helping online instructors increase course quality and given the fact that there is lack of research on the pedagogical issues of online interactions (Kearsley, 1995; Jiang & Ting, 1999), the current study is conducted to investigate how interactions are promoted in practice and whether they align well with student preferences for online interactions.

Research Questions

Specific research questions of the study are:

- Q1: Which instructional activities are used to promote learner-instructor, learner-learner, and learner-self interactions in online learning environment?
- Q2: What are the learner preferences for these instructional activities? Are there discrepancies between student experiences and preferences of these activities?
- Q3: Why do learners prefer certain instructional activities over others? How we can change current practice to make online learning a more pleasant experience for learners?

Methodology

This study was conducted in a large mid western university. The survey was distributed to a total of 463 online MBA students and alumni. A total number of 188 students responded and the response rate was 41%. Survey respondents who were willing to participate in the follow-up interview were asked to provide an e-mail address when filling out the survey. Among these volunteers, 11 students were selected for a 45-minute one-on-one telephone interview.

Results

Results showed that online interactions happen primarily through team-based collaborative tasks, prompt feedback from instructors, asynchronous lectures, asynchronous discussions, sharing resources with peers, and regular office hour consultations. Anything requiring synchronous involvement or taking role in class activity is not used much currently in online learning. Learner self-reflection on the subject matter happens mostly through reading discussions, using what has been learned in real life situations, and in responding to questions independently. Online learners don't usually "come to class" with questions prepared.

As shown in the Table 1.1, the rank order of the experiences and preferences are fairly consistent with each other except the "check on student progress regularly." Instructor checking on student progress regularly was not perceived as a frequently occurring activity, but it was preferred higher (ranked 3rd) on the list. This indicates that students want to be checked on their academic progress regularly by instructors.

Table 1.1: Relative ranking differences of experiences and preferences for learner-instructor interactive activities

Instructional activities for learner-instructor interaction	Ranking Experiences	Ranking Preferences
Prompt feedback	1	1
Asynchronous lectures	2	2
Instructor participate in class-level discussions	3	3
Regular office hours for consultation	4	5
Grade on student responses to discussion questions	5	7
Check on student progress regularly	6	3
Instructor participate in group-level team discussions	7	6
Social communication with students	8	6
Synchronous lectures	9	9

Among all the learner-learner interactive activities, "having class-level large group asynchronous discussions" had the largest ranking difference between its experiences and preferences order on the list. The reasons for this relatively huge rank order difference was addressed in the follow up interviews. Although it was used often in practice, student did not prefer to engage in class-level large group discussions. Follow up interviewed revealed that the reasons were mainly because of the large class size, duplicated ideas, and unclear rules and expectations.

Table 1.2: Relative ranking differences of experiences and preferences for learner-learner interactive activities

Instructional activities for learner-learner interaction	Ranking Experiences	Ranking Preferences
Have team-based collaborative projects and assignments	1	2
Have small-group asynchronous discussions among students	2	4
Share course-related information and resources with my peers	3	1
Have class-level large-group asynchronous discussions	4	8
Have informal chats with peers where we share experiences and beliefs etc	5	3

Have synchronous chat sessions for students to engage in "real-time" discussions	6	7
Give feedback to my peers	7	6
Get feedback from my peers	8	5
Utilize task roles	9	11
Have student online debating team activities	10	10
Have online role-playing activities (e.g., playing different roles in a case).	11	9

The relative ranking differences of experiences and preferences in Table 1.3 illustrate that "reading over each other's discussions in the online forums" was the most frequently used learner-self interaction activity; but it was not the most preferred item on the list (ranked fifth). The reasons for low preferences toward this activity were similar to the reasons for low preferences toward the class level large group discussions. These low preferences were mainly due to the large class size, duplicated ideas, and lack of instructor participations in discussions.

Table 1.3: Relative ranking differences of experiences and preferences for learner-self interactive activities

Instructional activities for learner-self interaction	Ranking Experiences	Ranking Preferences
Read over each other's discussions (both on-going and archived discussions) in the online forums	1	5
Apply what have learned in real life situations	2	1
Be given individual problem-solving opportunities such as responding to questions independently	3	4
Reflect regularly on what have learned	4	2
Summarize take away key points of major topics or discussions.	5	3
Prepare questions before next class or academic topic	6	6
Write critiques or reflection papers about key course topics or concepts	7	7
Keep an electronic study journal	8	8

Online learners prefer receiving prompt feedback, participating in asynchronous lectures and discussions, sharing resources and experiences with peers, and participating in team-based task collaborations. It is interesting to note that learners prefer to have informal chats with peers more than to engage in class discussions and getting/giving feedback to each other although their experiences survey has revealed that informal chats among learners only happen sometimes. Another important finding is that learner preferences toward class-level asynchronous discussion has ranked much lower even though it is used quite a lot in online learning. In terms of learner-self interactions, online learner preferences for reading each other's discussions ranked much lower although it is the most frequently used instructional activity that promotes learner-self interaction. Most of the preferred activities are not regularly advocated in online courses. The effectiveness of online courses can improve a lot if instructors often ask students to engage in interactive activities. The qualitative data provides a number of detailed explanations over some of the "why" questions which are discussed in the following section.

Discussions

Discrepancies exist between learner experiences of and preferences for learner-learner interactions. The survey data showed that online students prefer informal chats with peers over engaging in class discussions and getting/giving feedback to each other; however, their experience survey revealed that informal chats among learners only happened sometimes. This indicates that online learners in this particular study hope to know each other more through informal chats. But, in actuality, such a desire to know peers does not have a high priority compared with those course-related discussions that students are required to engage in. As a result, informal chat with peers remains as a desirable, but not a have-to-do, activity. This point was further illustrated by student interview data.

> "…everybody's really busy and if I spend time socializing with them, it means that I have that much less with my family…for the most part, I'm not looking for friendships and social opportunities with my peers, except for professional networking and career development." (Aden)
>
> "Obviously the course is actually what you are there to do; personal interaction without course work is meaningless. It's nice but it doesn't really help…but there are still people that I keep in touch with…I think that is something that I want to do a lot more of, try to keep those relationships going." (William)

Another finding is that learner preference for class-level asynchronous discussion ranked quite low on the list of learner-learner interaction items, even though it was used quite often in online learning. This shows that online learners may have had unpleasant experiences with class-level discussions in the past. Since class-level discussion is one of the frequently used instructional methods in online education, it is critical to understand why students do not prefer to have class-level discussion as much. How can it be improved? These issues were addressed in the student interviews. Results indicated that the relatively low preferences for class-level discussion were related to large class size, repetitive postings, and the way in which professors set rules and expectations.

> "I don't like the entire class discussions because so many people go in there and they end up posting the same thing that's already been said 18 times" (Aden)
>
> "I like [whole class discussions] if the class is small…[otherwise] impossible to do it that way. I am very frustrated with that…Because there are too many people. You cannot have an actual conversation with 100 people." (Jessica)
>
> "The successful forum discussions that I've been involved in, really enjoyed and learned from, the professor set ground rules…And one of the things that has helped is to understand that the forum is not a place to say, yeah that was great…you wouldn't want to read a lot of material that was meaningless and probably repetitive of what others have said." (William)

Obviously, class-level discussions can become overwhelming if there are too many students in a class. It takes extensive time to read through all the discussions in that case. It can be boring and time-wasting if there are multiple postings that reflect similar ideas. While asked to provide suggestions for improvement, students recommended a number of strategies.

> <u>Dividing up the class into a few groups</u>:
>
> "One thing that I like … is combining the individual teams of 3, 4, 5 people into groups of teams so there are four or five teams in a group and we just post to that group. So instead of having to read 100 people's posts I just get to see a nice cross section of two or three other teams so it limits it to about 20-30." (Matthew)
>
> "It is not necessarily the entire class posting. So a class of 70 students maybe there's a forum for 35 and there is another forum for 35 and that's a reasonable number." (William)
>
> <u>Professor participation in discussions</u>:
>
> "I like it as long as professors are involved in discussion. I don't particularly like it when they just start a topic and let the class kind of go at it." (Richard)
>
> "We would like to hear the authority of what it should be or what it could be and that kind of thing. So it is like a little direction on the forum. And that I would prefer." (Sandra)
>
> <u>Setting clearer rules and expectations</u>:
>
> "There needs to be rules set up ahead of time in terms of what the expectations are of the discussion. If the topics are too general, that is when the discussions become somewhat useless." (Richard)
>
> "Sometimes it is kind of vague and you don't always know what you are supposed to say. So it is good to have kind of a specific target of what you are supposed to be talking about." (Paulo)

From the student follow up interviews, we could tell that the relatively low preference for class-level discussions in this study was not because students thought it was unnecessary, but because such discussions were not conducted in an effective way. Students admitted the importance of having class discussions.

> "I actually love the forum. I think that is where I learn the most."
> (Sandra)
>
> "The process of discussion, debate, interaction and all that are as important as the actual outcome because I learn a lot from other peoples view points. What they're saying, that's very useful."
> (William)

Given the critical role of class-level discussions in online learning, instructors should always consider how to make it more effective and enjoyable to learners. As Raleigh (2000) pointed out, "planning and implementing the online discussion is key to avoiding the common problems experienced with online discussions." I hope the student suggestions for forum improvement in this study provide useful insights for effective planning and implementation strategies for online instructors to utilize in promoting learner-learner interactions.

Students prefer certain activities over others in learner-self interactive activities. Survey results suggested that online learner preferences for reading others' discussions ranked low, although it was the most frequently used instructional activity among a list of activities that promote learner-self interaction. This result could be related to the earlier finding of low student preferences for class-level discussions. If there are too many discussion entries, multiple postings of the same ideas, and an overwhelming amount of postings, it becomes boring and time consuming to read through discussion forums.

Utilizing what was learned in real life situations, reflecting on what was learned, summarizing key points of topics, and solving problems independently were more preferred by online students compared with reading others' postings. The interview data provided further explanations on why students tended to prefer certain activities over others in learner-self interactions. Engaging in these self-interactive activities helps students internalize the knowledge, makes the learning outcomes more visible, and also helps students solve work-related issues.

> "I mean, I always look at the way what we are learning applies to my current job and constantly reflect on it or take notes or you know, figure out ways to make it my own…I would say the majority of what I get out of my MBA and my classes is that internalization" (Richard)
>
> "Yeah, I like to try to apply such and such an idea perhaps to work and I like it when my employer knows that I'm applying those principles since he's paying for my MBA." (Aden)
>
> "Yeah, it's come in pretty handy…I tried to apply what we were learning to my actual job and actually came up with some pretty good ideas from that." (Amid)

The relatively large gap between preferences for and experiences of learner-self interactive activities indicated most of these self interactive activities were not implemented enough in online courses. The effectiveness of online courses can improve greatly if instructors encourage students to engage in self-reflective activities. From a constructivist standpoint, learning happens when individuals internalize knowledge. Self-reflective activities can make knowledge internalization more effective and long-lasting.

Implications

The significance of this study is two-fold. First, from a practical point of view, the results of this study can provide empirical grounds for understanding student preferences for instructional activities that promote online course interactions. Such an understanding can help practitioners modify their instructional strategies to offer a satisfactory course. Second, findings can contribute to the knowledge associated with the use of instructional activities as mechanisms for generating online course interaction and thus inevitably enrich the body of literature on enhancing online course quality in general. To my knowledge, such empirically-based research study is greatly needed in the field of online education.

Conclusions

People often choose to learn online because of its flexibility and convenience. While accommodating typical online learner needs for flexibility and convenience, ways to enhance learning outcomes becomes a major concern of current online learning practices. Meeting learner preferences for learning activities definitely serves as a starting point for delivering a satisfactory educational experience for busy working professionals who choose to learn at a distance.

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EFFECTS OF COLLABORATION MODE AND GROUP COMPOSITION IN COMPUTER-MEDIATED INSTRUCTION

Jeremy I. Tutty
Boise State University

James D. Klein
Arizona State University

Abstract

This study investigated the effects of collaboration mode and group composition during a collaborative computer-based program. Each of six intact sections of a computer literacy course was assigned to either a face-to-face or a virtual, online collaboration treatment condition. Groups consisted of homogeneous lower-ability, homogeneous higher-ability, or heterogeneous mixed-ability pairs. The study examined the effects of collaboration mode and group composition on individual posttest performance, group project performance, collaborative interaction behavior, and attitudes towards the instruction. The findings suggest that both virtual and face-to-face collaboration can be effective in achieving learning goals. However, consideration should be given to the collaborative structure of the lesson and the type of task in the design of computer-mediated collaborative environments.

Introduction

The use of the Internet and telecommunication technologies in education has increased in recent years with the proliferation of online learning. In 2002, more than two million college students were estimated to be enrolled in some form of web-based education. It is estimated that more than 90 percent of U.S. colleges and universities offered online options in 2005 (The Chronicle of Higher Education, 2005).

This movement towards online learning has prompted educational technologists to debate the most appropriate role for new technology (Golas, 2002) and motivated an educational paradigm shift from single-classrooms to knowledge-building communities of learners (Chou, 2001; Ravits, 1997). Advocates of computer-mediated collaboration (CMC) point to constructivism as the theoretical perspective for explaining its effectiveness (Kanuka & Anderson, 1998). Theorists suggest that learning is more effective when students are able to discuss their ideas, experiences and perceptions with peers (Jonassen & Kwon, 2001; Kanuka & Anderson, 1998). Some researchers have indicated that the flexibility and technological support for such interactions available in computer-mediated environments point to collaborative learning strategies as a promising means to implement new technology (Laffey, Tupper, Musser, & Wedman, 1998; Pena-Shaff & Nicholls, 2004; Strijbos, Martens, & Jochems, 2004; Oliver & Omari, 2001). Furthermore, theorists have indicated that CMC could have greater effects than other modes of interaction on learning in problem-solving, case study, and other higher-order learning situations (Adelskold, Alklett, Axelsson, & Blomgren, 1999; Johnston, 1996; Jonassen, Prevish, Christy, & Stavulaki, 1999).

Researchers have shown that collaborative learning strategies in the classroom setting can positively affect learning outcomes, social skill development, and self-esteem (Johnson & Johnson, 1996; Slavin, 1990). Research also provides support for the use of collaborative learning strategies when students use computer-based instruction (CBI) (Cavilier & Klein, 1998; Dalton, Hannafin, & Hooper, 1989; Klein & Doran, 1999; Hooper, 1992; Hooper & Hannafin, 1991; Sherman & Klein, 1995).

Despite the positive findings for the use of collaborative strategies in CBI, there is little empirical evidence to indicate if the positive effects of collaborative learning on achievement transfer to environments where communication is mediated by computers. Much of the research on online learning has focused on student rates of participation and learner interaction (Macdonald, 2003; Pena-Shaff & Nichols, 2004; Sapp & Simon, 2005; Vrasidas & McIsaac, 1999). According to Hara (2002) and Murphy and Collins (as cited in Uribe, Klein, & Sullivan, 2003), research on synchronous CMC has been limited to surveys of students, investigations of the recreational use of online chat systems, and the use of these systems for instructional purposes has been explored only through case studies. Furthermore, among the studies that have examined achievement in the online environment, many consider only one collaborative condition rather than make a comparison of online to face-to-face situations (Berge, 1999; Brewer, 2004; Davies & Graff, 2005; Gunawardena & McIsaac, 2004; Hoskins & van Hooff, 2005; Laffey et al, 1998). Unless comparisons are made, it is difficult to determine the effect of computer-mediated collaboration (CMC) in virtual environments.

Another variable that may influence outcomes in collaborative learning settings is ability grouping. Ability grouping is the assignment of participants to small groups based on academic ability. Several studies have addressed ability grouping in face-to-face collaborative environments. However, there appears to be no single best way to divide students into learning groups. Some of these studies suggest that heterogeneous ability-groupings assist students of all ability levels with the acquisition of knowledge and the cognitive processing of this knowledge (Johnson & Johnson, 1996; Slavin, 1993). But other studies suggest that for the optimal development of thinking strategies and maintenance of self-esteem, group members should have similar cognitive abilities (Saleh, Lazonder, & De Jong, 2005).

Researchers who have advocated heterogeneous grouping by ability suggest numerous potential benefits for the higher-ability partners in these groups (Johnson, Johnson, & Holubec, 1996; Sharan & Sharan, 1992; Slavin, 1990). Heterogeneous groupings may support the academic achievement of high ability students by providing opportunities for deeper cognitive processing through the explanation of their own understanding to their partners. It is also suggested that higher-ability students acquire increased motivation and improved self-confidence. However, other studies have shown a negative or no impact on higher-ability students when paired in heterogeneous dyads (Hooper, 1992; Hooper & Hannafin, 1991; Sherman & Klein, 1995). Other studies suggest that homogeneous grouping may be the best when working collaboratively. Swing and Peterson (1982) found that students of average ability perform better in homogeneous groups than in heterogeneous groups. Hooper and Hannafin (1988, 1991) found that heterogeneous groupings have a negative impact on the achievement of higher-ability students. This is consistent with the findings of Sherman and Klein (1995) in which the confidence of higher-ability students was negatively affected by heterogeneous grouping.

Research also suggests that the efficacy of collaborative groupings is related to the interactions students exhibit when working in small groups. According to Sherman and Klein (1995), "Studies in which group member interactions have been recorded and analyzed indicate that achievement and attitude differences are related to the type and amount of verbal interactions between students" (p. 6). Webb (1989) reported that students in small groups who give or receive explanations during a lesson learn more from the lesson than those who do not. King (1989) found that small groups that asked task-related questions, discussed strategy, and elaborated solutions were more successful at problem solving than groups that did not exhibit these interaction behaviors. Gunawardena and Zittle (1997) noted that social interaction between learners could contribute to learner satisfaction and frequency of interaction in online or web-based instruction.

More recent research has shown that the mode of collaboration also impacts the frequency and quality of student interactions in collaborative environments. While some studies have found that participation and interaction is reduced in computer-mediated environments when compared to a face-to-face condition (Fahy, Crawford, & Aely, 2001; Vrasidas & McIsaac, 1999), much of the research has indicated that the quality of learner-learner interactions in a computer-mediated environment may actually be better than interaction in a face-to-face environment (Oliver & Omari, 2001; Sapp & Simon, 2005; Uribe et al, 2003).

The present study was designed to investigate the effects of two levels of collaboration mode (virtual or face-to-face) and the composition of groups (homogeneous higher-ability, homogeneous lower-ability, or heterogeneous mixed-ability dyads) within the context of computer-mediated instruction. Data on individual performance, group performance, attitudes, and time on task were collected for all participants. Data were also collected on the quality and frequency of learner-learner interactions in both the face-to-face and virtual collaborative condition. This study addressed the following research questions:

1. What is the effect of collaboration mode (virtual or face-to-face) on individual posttest performance, group project performance, attitude, and group member interaction in a computer-mediated, collaborative setting?
2. What is the effect of group composition (homogeneous higher-ability, homogeneous lower-ability or heterogeneous mixed-ability dyads) on individual posttest performance, group project performance, attitude, and group member interaction in a computer-mediated, collaborative setting?
3. What is the interaction effect of collaboration mode and group composition on individual posttest performance, group project performance, attitude, and group member interaction in a computer-mediated, collaborative setting?

Method

Participants

The participants for this study were 120 undergraduate preservice teachers enrolled in a computer literacy course at a state university in the northwestern United States. All participants were completing prerequisite requirements for entry into the upper division teacher certification program. The sample included students enrolled in six sections of the course. Participants were predominantly Caucasian female (69%), with a mean age of 22, from all major content areas.

The computer literacy course met twice a week for 75 minutes, and introduced basic technology skills in word processing, spreadsheets, databases, and presentation software. The Blackboard course management system was used as a supplement to face-to-face instruction in the course. Assignments were related to the basic function of each application, and face-to-face collaborative groups were often used during activities related to integration of technology into the classroom. In addition, this course prepared participants to take a state-mandated technology competency exam, which must be passed to receive credit for the course.

Materials

A computer-based instructional module on the basic functions of Microsoft Excel and the application of spreadsheets in the classroom was written for this study. It consisted of three parts: an introduction, a practice problem, and a group application project.

The program was specifically designed for use by collaborative dyads. Two scores contributed to the grade each student earned from the CBI lesson - one score was from a group application project each dyad completed as part of the program and the other score was from a posttest each individual completed at the end of instruction. Students were informed in the introduction that each score would contribute equally to their final score for the spreadsheet assignment.

The introduction contained 16 screens which provided information for students' successful use of the program. It began with a brief demographic questionnaire, followed by instructions for using the program such as, where to click to advance to the next screen, and how to return to previous instruction. The introduction then presented a description of the collaborative nature of the lesson, the goals and objectives of the program, and an overview of spreadsheets, and encouraged students to help each other learn. A collaborative skills review reminded students to: give explanations when their partner asked for help, ask about their partner's perceptions of the concepts, and wait to proceed through the instruction until their partner is ready. In addition, the review emphasized the importance of summarizing and listening when working collaboratively. The introduction concluded by informing students they would be learning about the basics of Excel, and would be required to develop a spreadsheet to solve some problems.

The practice problem component of the instruction consisted of 70 screens containing a classroom based scenario. Students assumed the role of a classroom teacher with the task of developing a class gradebook. The gradebook activity required students to determine several elements to include: class title, student names, assignments (homework, projects, quizzes, and exams), and the contribution of each assignment to the final grade. The gradebook would be formatted to calculate: student performance in each assignment category, student performance for the grading period, students' final grades as a percentage and letter, the class average for each assignment, and the highest and lowest grades for each assignment. The gradebook would also include a graph. Completed gradebooks were then saved to each student's network folder and the file path submitted to the researcher through the CBI, permitting the group to proceed to the group application project.

To encourage collaboration throughout the instruction, the practice problem was structured in two parallel tracks following a modified Jigsaw procedure (Aronson, Blaney, Sikes, & Snapp, 1978). Each track contained different skills required during the practice exercise so that one student could not receive all of the information necessary to complete the practice exercise independently. Once a student selected a track, they were unable to access the other track. This required each student to learn skills from, and teach skills to, their partner. Tracks were accessed by clicking the appropriate button.

Both tracks presented the student with a list of concepts and terms that should be defined and mastered. The tracks contained brief explanations and screen captures to illustrate the definition and function of each element in the instruction. Students were informed of the objectives and content within both tracks to ensure that all participants were aware of the skills required of the individual posttest. The program also contained a reminder that all of the skills included in both content tracks were required of the group application project.

A coder track, consisting of 32 instructional screens, covered the use of formulas and functions in Microsoft Excel. A designer track, consisting of 23 instructional screens, covered the formatting of a spreadsheet for efficient use. The remaining 15 screens were common to both tracks. These screens concluded the practice activity by providing instruction and practice on the Excel chart wizard.

The group application project consisted of a second spreadsheet activity, which required the same skills covered in the gradebook practice section. The group application project comprised the final seven screens of the CBI. No additional instruction was provided for this activity, but students were able to access their previous content track for review. Students had to determine on their own how best to complete the project. One application project was submitted per group.

Procedures

This study included six different treatment groups. Each of the six intact sections of the computer literacy course was assigned to either a face-to-face or virtual collaboration treatment condition. Using randomized block sampling within each class, participants were blocked by ability and assigned to dyads in one of three ability compositions (homogeneous low, homogeneous high or heterogeneous). Ability blocking was based upon performance on a general computer ability pretest. A one-way analysis of variance (ANOVA) conducted on the pretest scores showed no significant differences between class sections prior to the study, $F(5,136) = .08$, $p > .99$. Due to the composition of each section, 38 students were assigned to higher-ability dyads, 40 to lower-ability dyads, and 42 to mixed-ability dyads. There were a total of 138 students at the beginning of the study. Data from 18 students were unusable due to absences during the study.

Dyads were given three, 75-minute class periods to complete the program and assessments. Student interactions were collected for each dyad during the first two days of the treatment by two trained research assistants. The frequency of these interactions were classified and recorded on an observation form.

On the first day of the treatment period, students in the face-to-face condition were verbally informed of their dyad assignments and asked to sit at a workstation next to their partner. Students were then asked to execute the installed CBI. Students in the virtual condition were informed they were participating in a simulation of a virtual environment, so all communication would take place using the synchronous chat feature of Blackboard. Partners in the virtual condition were not seated in proximity of one another or aware of each others' identity until logging in to Blackboard. Participants in both conditions were instructed to run Microsoft Excel along with the CBI.

The second day of instruction was nearly identical to the first. Students in both conditions were asked to return to the workstation they used the previous class period and resume the lesson. Students in the virtual condition were again be reminded they had to login to Blackboard to communicate with their partner. At the conclusion of the second class period groups were required to submit their final projects. Any students finishing before the end of the period were excused.

An individual, computer-based, multiple-choice posttest covering the instructional material was administered to each student on the third day on instruction. Students also completed a Likert-type attitude survey, and five students from each treatment condition were randomly selected to participate in a short interview.

Data Collection Instruments

Six measures were used to collect data in the study. Participants completed a general computer ability pretest for assignment to ability groups. During instruction, student interactions were collected. Following instruction, participant performance was measured by a project scoring rubric and a posttest. Students also completed an attitude survey and interview after instruction.

Several weeks prior to the implementation of the study, a 25-item, computer-based, multiple choice pretest measuring general computer ability was administered to the participants. This pretest was used to determine student ability for assignment to dyads. The pretest contained five knowledge items from five of the test categories: the computing environment, word processing, presentation software, spreadsheets, and databases. Each pretest item was worth one point. All pretests were scored by the primary researcher.

A 25-item, multiple choice, computer-based posttest was administered during the week following the spreadsheet CBI. The test included items based on the program objectives, measuring knowledge and skills covered in the instructional program. Participants were required to identify various spreadsheet functions, terms, and the output of a given formula. Each posttest item was worth one point, and all posttests were scored by the primary researcher. The split-half reliability coefficient of the posttest was .88.

An attitude survey was developed to measure students' reactions to the instruction. It contained 18, five-choice Likert-type items (4 – strongly agree, 0 – strongly disagree) and three open-ended questions. The survey included three sections, delivery system, topic, and collaborative work.

A six-item interview protocol was developed by the researcher to follow the attitude survey. Five participants from each treatment condition were asked both forced-response and open-ended questions related to their opinion of the program, the helpfulness of features of the program, and the perception of collaborative learning in each treatment condition.

The primary researcher developed a rubric to evaluate participant performance on the group project. Due to the nature of the problem, there was not a single correct answer. Therefore, students were evaluated on the inclusion of content, the accuracy of their calculations, and the format of their output. For inclusion of content, participants were evaluated on their efficiency in using the data provided. For accuracy of calculations, participants were evaluated on conducting the correct calculations and if all equations were accurate. For output, participants were evaluated on their clarity in formatting the spreadsheet. The group project spreadsheets were blind scored by one of two evaluators to prevent bias. Inter-rater reliability for a random sample of 15 student projects was .90.

Student interactions were collected for each dyad during the study using two different means. In the face-to-face condition, dyads were observed by trained research assistants. Each instance of collaboration was indicated on an observation form. Raters identified each dyad by number, but were unaware of the dyad's ability composition to avoid any bias. Each dyad was observed in two minute intervals at various points throughout the program comprising a minimum of 20 minutes of observation during the instruction.

Interactions in the virtual condition were captured using the virtual classroom session log feature of Blackboard. The log files for each dyad were exported to a database for analysis by the primary researcher, and examined for the same collaborative behaviors as the face-to-face dyads. To ensure an equivalent comparison of interactions between the face-to-face and virtual dyads, time stamps for each interaction were used to reconstruct the class session on a timeline. Two-minute intervals were then systematically categorized to simulate the observations of the face-to-face dyads.

Design and Data Analysis

This study used a quasi-experimental, posttest-only control group design. It was a 3 (group composition: higher-ability dyads, lower-ability dyads, and heterogeneous dyads) by 2 (collaboration mode: face-to-face and virtual) factorial design.

Group measures were analyzed using analysis of variance (ANOVA) on group project performance. Individual measures were analyzed using ANOVA on posttest performance and separate 3 x 2 MANOVA's on each factor of the attitude survey. ANOVA's on each dependent variable were conducted as follow-up tests to the MANOVA's. Follow-up univariate and Tukey HSD analyses were used where appropriate. To control for Type 1 error, each follow-up ANOVA was tested at the .01 level. Interaction frequency data were analyzed using Chi square analyses. Interview responses were categorized and reported by theme.

Results

Posttest Performance

Means and standard deviations for individual posttest performance are reported in Table 1. The mean posttest score for all participants was 18.15 (SD = 2.84) out of a possible score of 25. The mean posttest score was 18.69 (SD = 2.70) for students in the face-to-face collaborative condition and 17.57 (SD = 2.90) for students in the virtual collaborative condition. Table 1 also shows that the mean posttest score was 16.70 (SD = 2.30) for students in homogeneous lower-ability dyads, 18.40 (SD = 2.80) for students in heterogeneous mixed-ability dyads, and 19.39 (SD = 2.78) for students in homogeneous higher-ability dyads.

Table 1

Means and standard deviations for individual posttest

	Group Composition			
Collaboration Mode	LL	HH	H/L	Total
Face-to-face				
Mean	17.00	20.25	19.00	18.69
(SD)	(2.64)	(2.05)	(2.34)	(2.70)
n	22	20	20	62
Virtual				
Mean	16.33	18.44	17.86	17.57
(SD)	(1.82)	(3.20)	(3.12)	(2.90)
n	18	18	22	58
Total				
Mean	16.70	19.39	18.40	18.15
(SD)	(2.30)	(2.78)	(2.80)	(2.84)
n	40	38	42	120

Note: The maximum score possible was 25 points.
LL = Homogeneous lower-ability dyads
H/L = Heterogeneous (mixed-ability) dyads
HH = Homogeneous higher-ability dyads

A 3 x 2 analysis of variance (ANOVA) was conducted to examine the effect of group composition and collaboration mode on individual posttest performance. ANOVA indicated a significant main effect for group composition, $F(2,114) = 10.79$, $p < .001$, partial $\acute{\eta}^2 = .16$. Tukey HSD pairwise comparisons conducted as a follow-up to this main effect revealed that individual posttest scores for participants in homogeneous lower-ability dyads were significantly lower ($p < .01$) than scores for participants in the homogenous higher-ability dyads and those in the heterogeneous mixed-ability dyads. There was not a significant difference between participants in the mixed-ability dyads and those in the higher-ability dyads.

ANOVA also indicated a significant main effect for collaboration mode, $F(1,114) = 6.43$, $p < .01$, partial $\acute{\eta}^2 = .05$. Participants in the face-to-face collaborative condition significantly outperformed those in the virtual condition. ANOVA did not reveal a significant interaction between group composition and collaboration mode.

Group Project Performance

Means and standard deviations for group project performance are reported for dyads in Table 2. The mean project score for all dyads was 21.77 (SD = 1.91) out of a possible score of 24. The mean project score was 21.23 (SD = 2.01) for dyads in the face-to-face collaborative condition and 22.34 (SD = 1.59) for dyads in the virtual collaborative condition. Table 2 also shows that the mean project score was 20.65 (SD = 1.79) for students in homogeneous lower-ability dyads, 22.38 (SD = 1.66) for students in heterogeneous mixed-ability dyads, and 22.26 (SD = 1.85) for students in homogeneous higher-ability dyads.

Table 2

Means and standard deviations for group project performance

	Group Composition			
Collaboration Mode	LL	HH	H/L	All Groups
Face-to-face				
Mean	19.64	22.00	22.20	21.23
(SD)	(1.36)	(1.93)	(1.96)	(2.01)
n	11	10	10	31
Virtual				
Mean	21.89	22.56	22.55	22.34
(SD)	(1.45)	(1.74)	(1.44)	(1.59)
n	9	9	11	29
Total				
Mean	20.65	22.26	22.38	21.77
(SD)	(1.79)	(1.85)	(1.66)	(1.91)
n	20	19	21	60

Note: The maximum possible score was 24 points.
LL = Homogeneous lower-ability dyads
H/L = Heterogeneous (mixed-ability) dyads
HH = Homogeneous higher-ability dyads

A 3 x 2 analysis of variance (ANOVA) was conducted to evaluate the effect of group composition and collaboration mode on group project performance. ANOVA indicated a significant main effect for group composition, $F(2,54) = 5.85$, $p < .01$, partial $\acute{\eta}^2 = .18$. Tukey HSD pairwise comparisons conducted as a follow-up to the main effect revealed that group project scores for dyads in homogeneous lower-ability dyads were significantly lower ($p < .01$) than scores for participants in the heterogeneous mixed-ability dyads and those in homogenous higher-ability dyads. There was no significant difference between the other group compositions.

ANOVA also indicated a significant main effect for collaboration mode, $F(1,54) = 5.93$, $p < .05$, partial $\acute{\eta}^2 = .10$. Participants in the virtual collaborative condition significantly outperformed those in the face-to-face condition. ANOVA did not indicate a significant interaction between group composition and collaboration mode.

Student Attitudes

Attitude scores were based on a 5-point, Likert-type scale (4 – strongly agree, 0 – strongly disagree). These data indicated that most students felt the computer program was easy to navigate (M = 3.18, SD = .79) and that they are better prepared to use spreadsheets after completing the program (M = 3.01, SD = .76). Most students thought the spreadsheet is a useful tool to know (M = 3.61, SD = .54), and the spreadsheet skills learned will help in my career (M = 3.35, SD = .62). Students also generally liked their assigned partner (M = 3.25, SD = .81). However, students did not respond as positively to working with a partner over working alone (M = 1.84, SD = 1.28) and did not feel that they learned the material better working with a partner than they would have on their own (M = 2.25, SD = 1.28).

Three separate 3 x 2 multivariate analyses of variances (MANOVA) were conducted to determine the effect of group composition and collaboration mode on each of the attitude factors (delivery system, topic, and collaborative work).

MANOVA conducted on the items related to the delivery system indicated a significant main effect for collaboration mode, Wilks's $\Lambda = .74$, $F(7,101) = 5.17$, $p < .001$. MANOVA did not show a significant main effect for group composition or an interaction between group composition and collaboration mode. Follow-up univariate analyses indicated a significant difference between collaboration modes on five of the seven items ($p < .01$). In all cases, students in the face-to-face collaboration mode responded more positively toward the delivery system than those in the virtual collaboration mode.

MANOVA conducted on the items related to the topic indicated a significant main effect for collaboration mode, Wilks's $\Lambda = .89$, $F(4,105) = 3.14$, $p < .05$. MANOVA did not show a significant main effect for group composition or an interaction between group composition and collaboration mode.

Follow-up univariate analyses indicated a significant difference between collaboration modes on two of the four items ($p < .01$). In both cases, students in the face-to-face collaboration mode responded more positively toward the topic than those in the virtual collaboration mode.

MANOVA conducted on the items related to collaborative work indicated a significant main effect for collaboration mode, Wilks's $\Lambda = .60$, $F(7,101) = 9.48$, $p < .001$. MANOVA did not show a significant main effect for group composition or an interaction between group composition and collaboration mode. Follow-up univariate analyses indicated a significant difference between collaboration modes on five of the seven items. In all cases, students in the face-to-face mode responded more positively toward collaborative work than those in the virtual mode.

Approximately 91% of the study participants who completed the Likert portion of the attitude survey also responded to three open-ended questions. When asked what they liked best about the program, 24 of 96 respondents mentioned that the CBI was interactive. For example, a respondent indicated that they liked the program because, "It was interactive; we could move at our own pace. I could go back if I didn't understand something." Twenty-two participants mentioned the helpful practice, 16 mentioned the step-by-step presentation, and 16 mentioned the access to different tracks. When asked what they liked least about the program, 30 respondents indicated the inability to copy from the program into Excel, 24 participants mentioned using chat, and 16 responded working with a partner.

Finally, when asked about how to improve the program, 24 of 96 respondents indicated that the program could be improved by not using partners, 20 students wanted more practice in the program, 16 students mentioned not using chat, and 12 mentioned increasing the discussion of functions in the program.

Student Interviews

Five participants from each treatment condition were interviewed to determine their opinions of the program (n = 30). Participants were first asked about their opinion of the program. Fourteen of the 15 students in the face-to-face collaborative condition and 12 of 15 students in the virtual condition indicated they liked the program. Many responses were similar to the following:

> I felt that the computer program was a good way to learn about spreadsheets. It not only taught the basics, but had us apply them at the same time. I liked it because it was informative, creative, and taught the basics of spreadsheets.

Other students said they liked the program because of the step-by-step presentation of information, or because students were required to teach what they had learned.

When asked about which parts of the program were the most helpful, 9 of 15 students in the face-to-face condition and 8 of 15 students in the virtual condition indicated the individual instruction component was the most helpful. Six students in the virtual condition said the practice project was the most helpful, while five students in the face-to-face condition mentioned the group project. When asked about which parts of the program were least helpful, seven students in the face-to-face condition and four students in the virtual condition indicated the inability to copy from the program into Excel was the least helpful component. Furthermore, four students in the virtual condition identified the Internet chat requirement as the least helpful.

Responses to questions about working with a partner revealed that 10 of 15 students in both the face-to-face collaborative condition and the virtual collaborative condition liked working with a partner. One of the students in the face-to-face condition made the following representative statement:

> I did prefer working with a partner; it was helpful to make sure I was doing things correctly, and for getting new ideas on our second project. I think the collaboration made things better for both of us because we were able to bounce ideas off each other.

A student in the virtual condition said, "It was fun to work with a partner in the spreadsheet lesson. I think it helped me better understand what I needed to know by having to explain it to someone else." Conversely, 5 of 15 students in both the face-to-face and the virtual collaborative conditions indicated they did not like working with a partner. Students responding less positively towards working with a partner found it difficult to, "keep going back to explain what I just learned", and indicated that working with a partner, "left a few gaps in my knowledge."

When asked about how the lesson was used to learn about spreadsheets, 17 of 30 respondents said they simply followed the instructions. Five of the 15 students in the virtual collaborative condition mentioned that they relied on learning from their partner, while only 1 of 15 students in the face-to-face condition mentioned learning from their partner.

Finally, students were asked about their opinion of using a similar program in the future. Twelve of 15 students in the face-to-face condition and 11 of 15 students in the virtual condition indicated they thought it would be a good idea to use a similar lesson in the future. Three students in each condition thought that it should depend on the subject. For example, one student said, "I don't think it would be useful for every application. It is really only good for basic procedural information." Only one student indicated that they thought it would be a bad idea to use a similar program in the future.

Student Interactions

Interaction behaviors were grouped into the five categories of questioning, answering, encouraging, discussing, and off-task. Separate chi-square analyses were conducted to determine the effect of group composition and collaboration modes on the number of interactions for each category. No significant differences were found within any of the interaction categories between ability groups. However, chi-square analyses indicated that students in the virtual collaborative condition asked more questions of their partners, $X^2 = (1, N = 29) = 5.13$, $p = <.05$, and exhibited more off-task interactions $X^2 = (1, N = 29) = 9.92$, $p = <.01$, than those in the face-to-face collaborative condition. No other significant differences were found for interaction behaviors. The observed instances of student interactions that occurred during the instructional program are reported in Table 3.

Table 3

Instances of student interactions

	Group Composition			Mode	
Interactions	HH	LL	H/L	F2F	V
Questioning*	120	145	161	188	238
Answering	90	98	130	145	173
Encouraging	51	39	58	63	85
Discussing	185	132	175	258	234
Off-task*	36	61	71	64	104
Total Interactions	482	475	595	718	834

Note: Total number of each interaction behavior for 60 dyads in 20 minutes of elapsed time observed in two-minute intervals.
LL = Homogeneous lower-ability dyads
H/L = Heterogeneous (mixed-ability) dyads
HH = Homogeneous higher-ability dyads
*p <.05 for mode

Discussion

This study examined the effects of collaboration mode and group composition on individual posttest performance, group project performance, student attitudes, and collaborative interaction behaviors. Students completed a collaborative computer-based program while communicating either face-to-face or by using

synchronous chat in a virtual, online setting. All participants were assigned to one of three group compositions based on general computer ability. These dyads consisted of homogeneous lower-ability, homogeneous higher-ability, or heterogeneous mixed-ability pairs.

Performance

Results indicated that participants in the face-to-face collaborative condition performed significantly better on the individual posttest than those in the virtual online condition. This finding likely occurred because face-to-face students found it easier to share information throughout the lesson than virtual students. This explanation is partially supported by results from the attitude survey which revealed significant differences in favor of students in the face-to-face condition for the following items: (1) I was able to adequately communicate with my partner; (2) My partner taught me what I needed to learn; (3) The checkpoints in the program helped my partner and me communicate; and (4) I liked the system for communicating with my partner.

Furthermore, observations of student interactions revealed that several face-to-face dyads used visual cues such as pointing to their screen to provide an explanation to their partner or to acknowledge understanding. Hara (2002) indicated that students are required to make assumptions about meaning when they collaborate in virtual environments because of a lack of visual cues obvious in face-to-face communication. Others suggest that student misconceptions may occur due to a lack of nonverbal interventions to signal misunderstandings and that students can become disoriented without visual anchors in a virtual environment (Ruberg, Moore, & Taylor, 1996; Sapp & Simon, 2005).

Observations in the current study also revealed that in a few instances, students in face-to-face dyads traded seats with their partner so that both students could work individually through each track, avoiding collaboration altogether. Slavin (1995) suggested that individual learning strategies are better than cooperative strategies when students are required to learn facts and procedures. The multiple-choice posttest in the current study required individual students to identify terms, spreadsheet functions, and the output of a given formula.

In contrast to findings for the individual posttest, dyads that collaborated virtually performed significantly better on the group project than those who collaborated face-to-face. The collaborative interactions of students in the virtual dyads likely influenced their scores on the group project. Observations conducted during the study revealed that dyads in the virtual condition exhibited significantly more questioning behaviors than dyads in the face-to-face condition. As the lesson progressed, the frequency of interaction increased for virtual dyads while it decreased for face-to-face dyads. Several students in the face-to-face condition were observed working independently on the group project.

Other researchers have found that student interactions influence learning and performance in collaborative settings. Hooper & Hannafin (1991) demonstrated that questioning contributes to learning in collaborative groups. King (1989) found small groups that asked task-related questions were more successful at problem solving than groups that did not exhibit such interaction behaviors. In a comparison of computer-mediated groups, Sherman and Klein (1995) reported that dyads exhibiting more helping behaviors such as asking and answering questions performed better than dyads exhibiting significantly fewer helping behaviors.

The interaction requirements for an inquiry type project, such as the group project in this study, may be better met by virtual collaboration than face-to-face. Theorists have discussed advantages of virtual over face-to-face collaboration for group problem-solving tasks. Jonassen et al. (1999) asserted that CMC environments are better suited for problem-solving activities. The process of writing and reflecting may encourage higher level learning such as analysis, synthesis, and evaluation, and promote clearer and more precise communication (Garrison, 1997; Jonassen & Kwon, 2001). A study by Uribe et al. (2003) found that computer-mediated groups experienced performance benefits from the medium when performing an ill-structured problem solving task.

In addition to the findings for collaboration mode, group composition had a significant impact on individual posttest scores and group project performance in the current study. As expected, students assigned to higher-ability dyads performed significantly better on both performance measures than students assigned to lower-ability dyads. Furthermore, mixed-ability dyads performed significantly better on both performance measures than students assigned to lower-ability dyads.

Student Attitudes

Turning to attitudes, participants were generally positive about the delivery system and topic of the computer-based program used in this study. However, attitudes toward collaboration were less positive. Most of the Likert-type survey items asking about collaborative work were rated lower than items about the delivery system and the topic. Furthermore, open-ended survey items revealed that many students disliked working with a partner and thought the program could be improved by eliminating collaboration.

These results likely occurred because the collaborative structure used in the study placed too many limitations on students' ability to interact naturally, especially for those in the virtual collaborative condition.

Results indicated that students in the virtual condition were significantly less positive than students in the face-to-face condition toward the delivery system, the topic, and collaborative work, with significant differences occurring on 12 of the 18 Likert-type items. Open-ended items revealed that half of the respondents in the virtual condition identified communicating via synchronous chat as the thing they liked least about the program. In addition, almost one-third of the virtual students who participated in follow-up interviews cited the chat system as the least helpful part of the program.

These findings are consistent with results from other studies. Uribe, et al. (2003) found that participants did not like virtual collaboration due to the difficulties of communicating via computer. Others have reported that students in virtual groups were less satisfied than those in face-to-face groups with instruction received from their partner (Olaniran, Savage & Sorenson, 1996: Warkentin, Sayeed, & Hightower, 1997).

Student Interactions

As discussed above, virtual dyads were observed to have significantly more questioning behaviors than face-to-face dyads. In addition, virtual dyads exhibited significantly more off-task interactions than face-to-face dyads. Many studies have detailed the importance of social interaction in computer-mediated communication (Chen, 2005; Jung, Choi, Lim, & Leem, 2002; Savenye, 2005). Anderson and Harris (1997) identified that socially oriented factors contribute to the prediction of performance in computer-mediated settings.

It is likely that the increased off-task behaviors for virtual dyads are a result of the necessity to establish a virtual social presence. It is interesting to note that while group composition did not have a significant effect on interaction behaviors, mixed ability groups exhibited the highest number of off-task interactions Perhaps heterogeneous groups have a greater need than homogeneous groups to establish a social presence.

Implications and Future Research

The results of this study have implications for the design and delivery of computer-mediated instruction in collaborative environments. Findings suggest that both face-to-face and virtual collaboration can be effective in achieving learning goals. However, consideration should be given to the type of learning task and the collaborative structure of the lesson when designing computer-mediated instruction. Face-to-face collaboration may be better suited than virtual collaboration to environments where the acquisition of well defined facts and procedures is desired. Furthermore, virtual collaboration may be better suited than face-to-face collaboration when solving ill-structured problems is the desired outcome.

It should be noted that results were obtained in an environment constrained by a rather rigid collaborative structure. Yet to be resolved is the question of what kind of collaborative structuring should be used to support positive outcomes in computer-mediated environments. Theorists have argued that ill-structured tasks are best addressed in open-ended environments and that well defined tasks are better addressed in more rigid environments (Jonassen, et al., 1999; Jonassen & Kwon, 2001). However, the results of this study seem to indicate that task type and structure are mediated by the mode of collaboration.

The current study also suggests that group composition should be considered when forming collaborative dyads. Regardless of the mode of collaboration, pairing two lower-ability students has a negative impact on learning facts and procedures and on solving problems. Results also confirm findings of other researchers who suggest lower-ability students may benefit from being paired with higher-ability students (Saleh, et al.,2005; Slavin, 1993; Uribe et al., 2003).

The interdependence of design considerations such as collaborative structure, task and collaboration mode should be further explored. Additional research is needed to determine whether a particular collaborative structure is better suited for certain types of tasks in a CMC environment, or if certain tasks are inappropriate for computer-mediated collaboration. As stated by Salomon (1999), "The fact that something is technologically possible does not imply that it is also educationally desirable" (p. 36). Research should identify the most effective instructional practices to promote the learning of various skills. Future research could also address the method for forming groups in online and face-to-face collaborative settings. Factors such as group size should be explored to determine an optimal size for learning in computer-mediated collaborative environments.

As the demand for online and distance education expands, more students will be required to work collaboratively to learn from computer-mediated instruction. The production of increasingly complex tools for virtual collaboration will challenge practitioners to implement the most effective strategies for learning. Educational technology researchers should continue to examine the factors that impact learning when students use web-based and computer-mediated instruction in collaborative environments.

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Designing ePortfolios for Learning Outcomes Assessment: Course to Program

Leah E. Wickersham, PhD
Sharon M. Chambers, PhD
Texas A&M University-Commerce

Introduction

Accountability demands to provide evidence of student learning has made universities focus on outcomes assessment. This emphasis on assessment has brought to the forefront the use of electronic portfolios to showcase what students have learned as a result of their university studies over time. Universities are being called to document new learning—what students know now that they did not know upon entering the university. Due to this outcomes emphasis alternative assessments to the traditional examinations are being employed for accountability purposes (Ruhland & Brewer, 2001). Because of the increased interest in learning outcomes assessment a divergent paradigm has emerged —assessment ***of*** learning and assessment ***for*** learning (Barrett & Carney, 2005). Universities find it necessary to use an outcomes assessment process and engage students in active, learner-centered activities, problem solving, writing, researching, analyzing, implementing, for a student to be a responsible, reflective learner. This process requires timely feedback to be provided to the learner to guide the student learning process—or assessment ***for*** learning. Assessment ***of*** learning, the more traditional process, is a summative assessment approach which may only tell part of the story of student learning. Astin (1985, 1996) states that students learn when they are in educational programs that provide learning environments where students are actively engaged, have high expectations and are given ongoing feedback. Current research recognizes the value of students situated in the construction of learning. Students involved in the process of learning make a decisive difference in promoting positive learning outcomes (Davis & Murrell, 1994). Universities have begun to devise and incorporate an assessment process which allows students to convey a better understanding of the depth and breadth, a richer story, a holistic picture, of what they know and are capable of doing (Niguidula, 1993).

The American Association for Higher Education (AAHE) outlined nine principles of good practice for assessment of student learning (Astin, Banta, Cross, El-Khawas, Ewell, Hutchings, Marchese, McClenney, Mentkowski, Miller, Moran & Wright, 1996). These principles of assessment suggest true formative assessment to track students' process and progress and monitor changes in their attitudes, values and thinking over time and involve students in the learning, teaching and assessment process. The principles help to inform program quality and allow students to not only demonstrate what they know, but what they are able to do with the knowledge. These principles embody the concept of an electronic portfolio. Through the use of electronic portfolios, the responsibility of learning is transferred to the students. It allows them to be involved and engaged in the learning process and therefore keeps the focus on the learner-centered environment. Hewett's (2005) research states that "as a model for learner-centered classrooms, e-portfolios give students ownership and responsibility for their own learning" (p. 27). The EDUCAUSE Learning Initiative definition of electronic portfolios was used in order to have a collective way of thinking (University of British as cited in Lorenzo & Ittelson, 2005). This definition describes ePortfolios as "personalized, Web-based collections of work, responses to work, and reflections that are used to demonstrate key skills and accomplishments for a variety of contexts and time periods" (p. 3).

Research on student perceptions of electronic portfolios provide evidence that students believe this environment enables them to demonstrate competence, critical thinking and personal development through reflections and professional growth of knowledge and abilities. Utilizing an electronic portfolio enables students to exhibit a constructivist approach to learning through active learner-centered activities such as problem solving, writing, researching, analyzing, and implementation of programs. Students are able to integrate and make connections from course to course, link items, and see associations as a result of reflections (MacDonald, Liu, Lowell, Tsai, & Lohr, 2004). Wilson, Wright & Stallworth (2003) found that students prefer to use electronic portfolios to self-evaluate their conceptual knowledge and show their ability to connect learning. Students are more engaged as a result of assessment through portfolios and their

personal theories, beliefs and practices come together in a cohesive bond. Students recognize that portfolios provided a process to showcase their learning and their students' learning and as a result, learning becomes their responsibility. They also note that organization, structure and technological skills are developed within a relevant context.

Teacher education students using an electronic portfolio for reflection say they more clearly understand pedagogical knowledge and are effective in the classroom and teaching areas where improvement is needed and can be developed. They have an increased self-efficacy and see teaching from a more holistic view-relating parts to whole. They believe it is an authentic assessment that chronicles student growth and competence. They provide a relevant personal journey and diverse types of evidence which is needed when measuring the depth and breadth of performance (Shaver & Avolos, 2004; Skawinski & Thibodeau, 2002). Students like the alternative approach to assessment that eportfolios offer, believe it has an impact on their learning, and information learned is retained better and longer because of the extensive reflecting on principles and application of concepts that is expected in the portfolio development process. They see that electronic portfolios provide an instrument for professional growth and acknowledge its usefullness where instruction and evaluation can be integrated. Evidence throughout the literature indicates students' perceptions are positive and favorable; however, the one drawback they offer is the time it takes to go over the required readings and time spent in developing their portfolio (Struyven, Dochy, & Janssens, 2002).

Purpose

The purpose of this paper is to present strategies/methods utilized to design and develop effective practices of assessment ***for*** and ***of*** learning using electronic portfolios and the lessons learned upon implementation. In addition, the effectiveness of this process after three semesters of implementation based upon program learning outcomes and graduate student perceptions of electronic portfolios as a method of assessment will be discussed.

Methods

Electronic portfolios have come to the forefront as an assessment process that "can enhance teaching, learning and assessment practices" (Lorenzo & Ittelson, 2005, p. 3). A regional university in North East Texas, in partnership with a local independent school district, used Astin's framework and the nine principles of good practice for assessment as a guide when planning a new and unique cohort master's degree program in Secondary Education. The goal was to provide the best system for documenting student learning outcomes and ways to assess the overall program quality. It was important to be able to use an outcomes assessment process that would actively engage students where they would be responsible, reflective learners and provide assessment information for feedback to guide the student learning process (assessment ***for*** learning) and inform program goals, objectives and field-based learning experiences for quality enhancement (assessment ***of*** learning).

Participants in this study were 26 members of a graduate cohort group working on their master's degree in Secondary Education. Feedback from students regarding the effectiveness of the electronic portfolio development process was obtained from a survey administered at the end of each semester consisting of thirteen Likert scale response questions, and four open-ended questions; two questions addressing the benefits and challenges of electronic portfolios and two questions addressing students' perceptions of electronic portfolios as a method of assessment or tool. Descriptive statistics were used to analyze the data from student survey responses in order to make comparasions over three semesters of changes in the three learning outcomes and responses from the open-ended questions were analyzed via the constant-comparative method (Glaser & Strauss, 1967).

Discussion

Strategies to Design, Develop and Implement Electronic Portfolios

The design, development and implementation of electronic portfolios within the graduate cohort centered around the concepts of nine principles of good practice (Astin, et al, 1996) and Astin's framework (1985, 1996) which support the notion of formative assessment, continuous feedback and revision, providing students with an environment to display evidence of learning via selected and prescribed artifacts, and continuous journaling/reflecting. The design of the portfolio began with the identification of program goals to determine what a student needs to know upon completion of the Secondary Education Master's degree. This overall goal identification assisted in determining goals/learning outcomes for each course within the program and the eventual determination of what students need to do in order to demonstrate achievement of learning outcomes in each course. Only two to three learning outcomes for each course were identified and assessment rubrics were developed and provided to students.

Within the first semester of implementation, it was quickly evident that students' technological skills varied from novice to expert and as a result, those with a low degree of technological self-efficacy became frustrated with the process of developing their portfolios. Instructors believed students would quickly develop those technological skills as a result of working within the electronic portfolio and progress has been made. Additionally, as a result of the range of technological abilities of students within the cohort, the design and creativity of the portfolios differed and it was from these differences that a new issue emerged. Instructors realized that an advantage of a portfolio assessment is that students can be evaluated individually based upon academic growth and progress from where their portfolio design began to how it evolved each semester. Individual progress and comparisons are more evident within the electronic portfolio environment. Portfolios chronicle student growth and competence over time through their reflection and self assessment allowing a window into their educational journey.

Sharing portfolios electronically allowed students to view their peers' work which was a source of reassurance, encouragement and inspiration through the sharing of ideas and artifacts. The electronic portfolio environment combined with the rubrics developed for each learning outcome also led to increased communications among the course instructors and students with opportunities for continuous feedback and revision outside of the classroom.

Initially, the concept of utilizing electronic portfolios as an assessment tool was foreign to both instructors and students; however, the implementation process started small and evolved over each semester adding new features of the system and new assignments/activities to encourage linking concepts from course to course. It is from these activities that the program is striving to provide a holistic and unique image of each student documenting their learning process and progress and over the course of three semesters both students and instructors have made steady improvements in technological skills and abilities resulting in more dynamic portfolios. Acceptance of the utilization of portfolios to assess student learning has also continued to grow. These improvements are evident within data collected in relation to the portfolio development process and are discussed next.

Effectiveness of Electronic Portfolio Development Process

The cohort is starting its fourth course out of six within the master's program, and to date data on three program learning outcomes from three semesters has been collected to determine whether the electronic portfolio development process assisted in the development of self-knowledge, technology and organizational skills development, and knowledge and skills transfer. The electronic portfolio development process is defined as "the design, development and sharing of one's electronic portfolio which contains evidence of ideas, knowledge and skills development as a result of class activities, reflections, communications and assignments to utlimately provide a holistic view that demonstrates an individual's growth as an educator" (Chambers & Wickersham, in press).

The program learning outcome of self-knowledge was defined as an increase in understanding of the relationship between theory taught in the graduate program as it pertains to the what, why and how of

individual careers. Within this learning outcome, students were asked to compare their growth over time through the analysis of their role as an educator each semester. Students also identified the changes that needed to be made for their professional growth. Specific areas surveyed within the self-knowledge outcome included the ability to view students, peers and supervisors through a different lens, and self awareness through journaling reflection exercises within their electronic portfolios as a result of new knowledge.

The program learning outcome of technology and organizational skills development was defined as an increase in technological skills and abilities, technological self-efficacy, communication, and organizational skills. Students designed and developed their electronic portfolio to provide an individualized perspective of their learning process and progress. It was through the process of building their portfolio, that students were expected to develop their technological and organizational skills and enhance their communication skills through journaling and conveying ideas and understanding of course content.

The program learning outcome of knowledge and skills transfer was defined as the ability to transfer the knowledge and skills developed throughout the master's program to their classrooms. Specific areas surveyed within this learning outcome were students' ability to identify and transfer specific skills relevant to their context and integrate those skills into their teaching based upon new information presented in the course. Students were also asked to document examples of changes in their own assessment practices and in their students' learning within the portfolio.

The focus of this paper is not specifically aimed toward a detailed discussion of these results and will be expanded upon in another article; however, it is important to note that after three semesters of implementation of the electronic portfolio development process there has been an overall continual improvement for items within the three learning outcomes. The following tables provide the percentage distributions and comparisons for items within the self-knowledge learning outcome (Table 1), the technology and organizational skills development learning outcome (Table 2), and the knowledge and skills transfer learning outcome (Table 3) for each semester (S1, S2, S3).

Table 1

Self-Knowledge Learning Outcome

	Agree			Neutral			Disagree		
Item	S1	S2	S3	S1	S2	S3	S1	S2	S3
1. Increase Knowledge in Teaching	33%	58%	65%	21%	19%	17%	46%	23%	17%
2. Reflections	46%	54%	57%	25%	35%	35%	30%	11%	8%
3. Why	42%	38%	39%	25%	46%	49%	33%	15%	13%
4. What	46%	62%	52%	21%	23%	30%	33%	15%	17%
*How	46%	N/D	N/D	21%	N/D	N/D	33%	N/D	N/D
5. Positive impact		58%	57%		27%	30%		15%	13%
6. View Peers		65%	78%		19%	22%		15%	4%
7. View Students		42%	43%		35%	43%		23%	13%
8. View Supervisors		42%	57%		42%	39%		15%	4%

*Question reframed
N/D=No data

Table 2

Technology and Organizational Skills Development Learning Outcome

	Agree			Neutral			Disagree		
Item	S1	S2	S3	S1	S2	S3	S1	S2	S3
1.Technology Skills	58%	73%	83%	30%	15%	13%	12%	12%	4%
2. Confidence	50%	65%	78%	46%	19%	17%	4%	15%	9%
3. Organization	33%	42%	43%	38%	35%	52%	30%	23%	4%
4. Communication	33%	31%	57%	38%	27%	30%	30%	42%	13%

Table 3

Knowledge and Skills Transfer Learning Outcome

	Agree			Neutral			Disagree		
Item	S1	S2	S3	S1	S2	S3	S1	S2	S3
1. Specific Knowledge	33%	69%	74%	21%	12%	17%	46%	19%	8%
2. Professional Knowledge	25%	58%	70%	30%	35%	17%	46%	7%	13%
3. Change in Student Learning	38%	46%	52%	8%	35%	26%	54%	19%	22%
4. Change in Assessment	38%	65%	74%	30%	27%	17%	33%	7%	8%

Student Perceptions of Electronic Portfolios

The open-ended questions at the end of the survey asked students to discuss the benefits and challenges of electronic portfolios, share their perceptions of electronic portfolios as a method of assessment or tool, and if they believed that the electronic portfolio better captured their overall learning and knowledge as opposed to other assessment methods.

In response to the benefits of utilizing electronic portfolios in their classrooms, the field of education and/or within the cohort, students believed that their electronic portfolio assisted in keeping them more organized, had the advantage of being both portable and paperless, and was easy to retrieve from any location with Internet access. Students within the cohort acknowledged the fact that their own students are more comfortable with technology and would most likely embrace this concept as a method of assessment. In addition, students from the cohort found that over time they were increasing their own technology skills while developing their portfolio and felt a sense of pride from sharing their work with their peers. Several students are seeing the portfolio as a marketing tool with the ability to search for new jobs and/or further their careers in higher education as they believe the portfolio demonstrates their growth as an educator.

The challenges of electronic portfolios within their classrooms, the field of education, and/or within the cohort were overwhelmingly identified as the technological skills needed to develop portfolios and for those individuals with a low degree of technological self-efficacy, the frustration experienced within the electronic portfolio environment can take the focus away from learning. To utilize electronic portfolios as a method of assessment within their own classrooms, technological equity can be an issue for both the school and the student regarding availability of resources. In response to utilizing electronic portfolios in her own classroom, one student stated, “The usual problems with students, the technology problems of teaching students to use it properly and the availablity to all students.”

Student perceptions of using electronic portfolios as a method of assessment expressed preference of this method as opposed to others such as a paper/pencil test, and believed that through their reflections/journaling exercises they were better able to express their ideas and look back on past assignments to observe progress made. The portfolio allowed for a broader expression of learning, immediate feedback on progress and a more “authentic assessment” that “personalizes learning” as opposed

to memorization and regurgitation of facts. However, students also acknowledged the fact that technology presents a barrier, but once overcome, the portfolio has potential to be a good tool for assessment. One individual noted, "When I write, when I put together my thoughts, ideas, insights, and reflections, I am more cognitively aware of my learning and growth. I believe that even a quick glance at my electronic portfolio would better illustrate my professional development than through looking at a typical assessment like a test over learned materials."

The final open-ended question on the survey asked students if they believed their electronic portfolio better captured their learning and knowledge as opposed to other assessment methods. Only one individual disagreed with this concept and did not elaborate. Responses overwhelmingly expressed satisfaction with electronic portfolios in representing their knowledge and understanding of course content. Students specifically targeted the reflections/journaling exercises as a way to provide a holistic view of their learning in that students are able to better clarify ideas and concepts to share with others what has been learned, review past projects/courses to compare to later work in order to see how their thought processes have evolved and changed, and the freedom to express thoughts and ideas specifically applicable to personal situations. One student stated, "I love being assessed via my eportfolio. I would much rather write about topics than be tested. I feel I've learned more in these three classes about myself as a teacher than I learned in four years of college." Another individual said, "I do believe the e-portfolios better captures overall learning than other methods because reflections captures a true sense of learning. There is no pressure of a test either which allows us to think about our learning."

Lessons Learned

Lessons learned from the implementation of an electronic portfolio system to document and assess student learning range from technological issues and barriers, the time involved for both students and instructors to develop and review, and the overall acceptance of electronic portfolios as an assessment method.

As indicated earlier, students came into the cohort with a variety of technological skills and abilities from the novice user to the expert. For students with a lesser degree of technological comfort/self-efficacy, the process of learning to use the eportfolio system in addition to developing technological skills can be extensive and lead to frustration and anxiety for the individual. A lesson learned from this experience is the need to create an electronic portfolio orientation course or workshop focusing on developing students' technological skills and increasing their confidence within the electronic portfolio environment prior to using this as a major program assessment tool. It is also important to provide continued technical support/assistance if and/or when new skills are required.

Sharing portfolios was a postive outcome from the implementation; however, it is important to recognize that students may not feel comfortable with having their "points of view" published on the Internet. And while the reflection process is integral to the portfolio this is an important issue. Electronic portfolio systems have the capability to password protect access to portfolios and this should be made an option to students especially if part of their grade is dependent upon the reflective exercises.

Developing and reviewing portfolios is a time consuming process for both the student and instructor. An important lesson learned from this implementation is to not only provide ample time to develop and review portfolios, but to allow students the freedom to add additional artifacts to demonstrate their understanding of specific concepts. The development of comprehensive rubrics can assist in providing students with a detailed analysis of their performance and save time for the instructor.

The implementation of electronic portfolios as an assessment method throughout the program was a difficult concept for students and instructors to grasp as it is dynamically different from traditional assessment measures. The road traveled by all involved with this process has not always been smooth; however, the consistent progress, changes in attitudes overtime, and the ability for both faculty and students to see the progress in learning have only solidified the notion that this is a quality measure of learning and one that will continue to improve with practice.

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How Are We Doing?
Understanding Faculty's Adaptation to Change in a Web-Based Environment

Paige Worrell, Ph.D.
Glenda Ballard, Ed.D.
Bosede Aworuwa, Ph.D.
Patricia Humphrey, D.B.A.
Texas A&M University - Texarkana

Introduction

Rapid change in technology continues to impact education profoundly. The convenience of accessing college classrooms from remote locations through web-based technology has made the prospect of attaining a college degree a reality for many adult students. This demand has, in turn, increased the need to provide courses through web-based formats. By necessity, many faculty have embraced web-based technology in order to meet the needs of today's college students. Those who have accepted this new classroom format have had to learn—sometimes "on the job"—how to use the classroom management system in order to provide the instruction.

Yet, despite the early influx of faculty who used the technology, known as *compassionate pioneers* by Feist (2003), the reality of actual use by faculty waned considerably once the novelty of the new toy wore off (Robinson, 2004). While studies that address the perspectives of students regarding the use of web-based course work may be found, very little research has been done that specifically identifies the concerns and attitudes of faculty. What are the concerns of faculty who actively participate in web-based instruction? How are these concerns addressed, if at all?

The purpose of this study was to examine the perceptions of faculty about web-based instructional technology. The significance of the study was to inform other faculty and administrators about faculty concerns regarding teaching in web-based environment and to provide insight into how to address those concerns for optimal learning outcomes for students.

Background

Faculty who opt to participate in web-based instruction come from all disciplines and with all levels of expertise regarding technology use. In addition, the accessibility of training, either in their own institutions or through professional associations, ranges from nonexistent to highly formalized. The adoption of any new mode of instruction often necessitates change in the individual using the methodology; indeed, as Bailey & Palsha (1992, March/April) state, "the impetus for change often comes from external sources" (p. 226). The peculiarity of online environments, in particular, necessitates a change in orientation and in pedagogy. Faculty members new to this environment experience stress in navigating the terrain to create effective learning experiences for their students. Learning to use the technology while simultaneously trying to use it to develop and deliver the course proves daunting for novice faculty (Choi & Park, 2005).

The literature of faculty concerns about teaching online has focused on factors such as lack of adequate infrastructure; training and technical support, administrative support; and effect of teaching online on students' learning outcomes (Kang, 2005; Wilson, 1998; Olcot & Wright, 1995). However, other concerns about teaching in this new format are yet to be addressed. Faculty adapting to the teaching of web-based courses go through a process that is highly personal, involves developmental growth, both affectively and cognitively, and can be influenced by timely interventions directed toward the individuals, the innovation, and/or the context in which the change is taking place (Wilson, 1998; Anderson, 1997). Additional research about the introspective perceptions of faculty will deepen our understanding of issues regarding the use of technology as an instructional medium.

One model which examines change in individuals, the Concern-Based Adoption Model (CBAM), applies to anyone experiencing change--administrators, policy makers, teachers, parents, and students (Hall & Hord, 1987; Hord, Rutherford, Huling-Austin, & Hall 1987). The purpose of CBAM is to determine the concerns that professionals may have about an innovation. Concerns are defined as "the composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (Hall, George & Rutherford, 1986, p. 5). The CBAM holds that people considering and experiencing change evolve in the kinds of questions they ask and in their use of the new technology. In general, early questions are more self-oriented: What is it? How will it affect

me? When these questions are resolved, then the questions that emerge are more task-oriented: How do I do it? How can I use these materials efficiently? How can I organize myself? Why is it taking so much time? Finally, when self and task concerns are largely resolved, the individual can focus on impact. Educators ask: Is this change working for students? Is there something that will work even better?

For this research project, the Concerns-Based Adoption Model was used as a basis for the development of a survey to allow us to examine the concerns that faculty have about the use of course management system and to compare their stages of concerns with their levels of use of the various tools in the course management system.

Methodology

The purpose of this study was to explore faculty concerns about web-based instruction and the use of web-based course management tools. Many concerns emerge when faculty begin to use course management systems and the various tools available in that system to design and develop web-based courses. The researchers sought to answer the following research questions:

1. What tools in a web-based course management system do faculty use?
2. What types of concerns do faculty have about using the tools of a web-based course management system?
3. Is there a relationship between faculty's stages of concern and their level of use of the tools of a web-based course management system?
4. If so, do faculty's discipline/teaching experience/access to training/years of use (familiarity with the tools), etc. have effect on that relationship?

Participants

The survey was piloted on faculty at Texas A&M University-Texarkana. A&M-Texarkana is a small, upper division university in Northeast Texas. The university has a total of 60 full time faculty and offers undergraduate and graduate programs in business, education, nursing, behavioral sciences, and liberal arts (including history, English, political science and math). The student body has a mean age of 33; while the population of traditional students is growing, the current population is still influenced by working adult students who are largely place bound and who seek degrees to improve their quality of life within the context of their existing environment. Web-based instruction provides a viable alternative access to education for this group of students. Faculty at the university were sent an e-mail that introduced the research project, encouraged them to respond, and provided a link to the online survey. Announcements were also made in two departmental faculty meetings regarding the survey. Due to the self-selecting nature of the survey unintentional bias may have occurred, and the results reflect the perceptions of only those who chose to participate.

Out of the 65 faculty, administrators and instructors invited to participate, 34 (52% response rate) completed and submitted the survey. Of the 34 submissions, 30 were completed by faculty, two by administrators, and two by those designating themselves as "other." Sixty-eight percent of the participants are female and 32% are male, which indicates a representative sample of the A&M-Texarkana faculty. Twenty-eight indicated they hold doctoral degrees and six responded as master's graduates. When asked how many years they have been involved in higher education, nine reported 1-5 years, eight reported 6-10 years and 17 reported 10+ years. Regarding discipline, five were from Business, fifteen were from Education, three were from Liberal Arts, four were from Sciences, and five indicated "Other."

When asked how long they had been involved in web-based instruction, 11 indicated "Never", while 20 indicated two, three, or four years; 3 indicated that they had five or more years. Of the 34 participants, 10 indicated they were novice, 15 marked intermediate, and 2 considered themselves advanced. When asked if they had received any training in using web-based course management platforms, 22 indicated yes and 12 indicated no. A total of 18 indicated that they had received training from the local institution. When asked about academic discipline, 12 were in education, 3 were in liberal arts, 4 in the sciences, and 5 were "other." Three people skipped this question. Finally, when asked about which course management platform the participant currently uses, 20 indicated WebCT, 2 indicated Blackboard, 1 uses eCollege, 1 uses WebCT Vista, 12 indicated no use, and 2 indicated "other."

Instrumentation

Stages of concern. According to Anderson, (1997), the CBAM theory "idealizes the Stages of Concern as a developmental progression in which teachers implementing a change have concerns of varying intensity across all seven stages at different point on the change process" (p. 334). Modeled on the Change Facilitator Stages of

Concern Survey (CFSOCG) of the CBAM (Hall, Newlove, George, Rutherford, & Hord, 1991), the first prong of the survey for this study consisted of 28 statements addressing the seven Stages of Concern (SoC) (Newlove & Hall, 1976). This study seeks to determine the current SoC for A&M-Texarkana faculty and explore possible relationships to their level of use of the course management system tools.

The Stages of Concern (SoC) component of CBAM is a framework that describes the attitudes and motivations a faculty member might have about the change in practice that occurs at different points during the implementation of web-based courses at their institution. At Stage 0, AWARENESS, the faculty member has little knowledge about or interest in web-based course management systems or the tools. At Stage 1, INFORMATIONAL, the faculty member has a general awareness of the tools and an interest in learning more. Faculty concerns at Stage 2, PERSONAL, are focused on the individual's uncertainty about demands of learning about the tools and the overall impact of the change in practice. At stage 3, MANAGEMENT, faculty tend to focus on the process and tasks of using the course management system, while, at Stage 4, CONSEQUENCE, faculty concerns begin to focus on the impact that their use of course management systems have on student learning outcomes. Once they feel more comfortable with their use of the course management system, their concern focus moves to Stage 5, COLLABORATION, where they focus on cooperation and coordinating with other faculty regarding the use of the tools for teaching and learning. When faculty begin to explore more universal benefits of using a new innovation, such as the course management system for web-based teaching and learning, they move into Stage 6, REFOCUSING.

Levels of use. The Levels of Use (LoU) component of CBAM is a framework that describes patterns of behavior as faculty progress through the implementation process (from NONUSE to RENEWAL). The second prong of the survey consists of a checklist of tools found in most common web-based course management systems such as WebCT, Blackboard, FirstClass, Elluminate, among others. The checklist contains response options representing the eight levels of use of an innovation of the CBAM. The response options include NON-USE (0), ORIENTATION (1), PREPARATION (2), MECHANICAL (3), ROUTINE (4A), REFINEMENT (4B), INTEGRATION (5) AND RENEWAL (6). Participants' responses signify their current level of use of each web-based course management tool.

"As with Stages of Concern, the CBAM Levels of Use schema represents a possible, not a necessary, developmental progression in teacher behaviors focusing on the implementation of a specific change in practice" (Anderson, 1997, p. 335). Web-based course management systems are multi-functional with a variety of tools, but we needed to identify specific changes in practice. Therefore, the checklist consisted of 26 web-based course management tools grouped according to functions they serve in a course management system. The categories are 1) course content development, 2) course management and usability, and 3) communication/live conferencing.

Instrument Development

Instrument development. The development of the survey involved both a collaborative and iterative process of four faculty members from A&M University-Texarkana. The research group includes two professors with backgrounds in instructional technology, one with a background in marketing, and one in adult education. All four participants teach courses online. Once the decision was made to use the CBAM as a model for the instrument, a checklist of tools in a typical web-based course managements system was developed and divided into three categories: course content development tools, course management and usability tools, and communication and live conferencing tools. A matrix was developed addressing each of these tools, and the participants were asked to check their level of use by assessing their level of expertise.

Next, the research group developed a series of open-ended statements using the CBAM stages of concern as a guide to determine the respondent's level of concern. The statements were modeled after statements of concern developed by Newlove and Hall in 1998. Seven stages of concern for each category of tools in web-based course management systems were addressed. The survey began with 43 statements and was pared down to a total of 27 items. Development of the questions included an iterative process whereby each of the stages of concern was assessed. Each question had the same response options, thus creating a likert scale for participants to self-evaluate themselves.

Following the development of the concern statements, the research group conducted a series of revisions for validity. First, the authors completed the survey independent of each other and the initial scoring was examined. Revisions were made. Then, the sample instrument was given to a representative audience of university faculty, which provided data for the next phase of revision. The authors completed an inter-rater reliability test to check for validity. A reliability test was performed on the scores using Cronbach's Alpha. It was confirmed that the Level of

Use questions adequately addressed the three categories of the Course Management System tools with a Cronbach's alpha = .848. The Stages of Concern questions also adequately address the seven stages with a Cronbach's alpha = .929.

Results

Level of Use

Information regarding the level of use was compiled using the Levels of Use categories and then collapsed into three broad categories. Category 1 included Non-Users, Orientation, and Participation levels; Category 2 included Mechanical, Routine, and Refinement; Category 3 included the Integration and Renewal levels. Table 1 illustrates the breakdown of the 34 participants.

Table1 Level of Use Responses (n=34)

Category	Levels of Use/ Tool	Non-Use/ Orientation/ Preparation	Mechanical/ Routine/ Refinement	Integration/ Renewal	# of Respondents per question
Course Content Tools	Page creation tool	21	11	2	34
	Content Module	21	11	2	34
	Glossary tool	29	5	0	34
	Image Management Tool	28	5	0	33
	Question Databases	24	9	0	34
	Assignment Tool	23	8	3	34
	Exam Tool	25	6	2	33
	Calendar	25	7	2	34
	Compile Tool	26	6	2	34
	Syllabus Tool	22	8	3	33
	Import/Export Course Content	21	11	2	34
Course Management Tools	Change Course Settings	16	15	2	33
	Reset Course	21	10	2	33
	Manage Files	12	18	3	33
	Share Access to Course	23	7	2	32
	Manage Students	16	14	2	32
	Track Students	17	13	3	33
	Track pages	21	8	3	33
	Manage Teaching Assts.	28	4	1	33
	Backup Course	23	7	2	32
Course Communication Tools	Student Presentation	25	4	4	33
	Mail	13	16	4	33
	Chat	26	4	3	33
	Interactive Whiteboard	31	1	1	33
	Student Home Pages	27	5	1	33
	Breakout Rooms	30	1	2	33
	Discussion Board	19	12	2	33

As shown in Table 1, the page creation tool and the content module are the most used of the course content tools while the glossary tool and image management tool are the least used. The assignment tool and syllabus tool are the ones that are most likely to be in a state of integration and renewal. Of the course management tools, managing files and changing course settings are the most used and managing teaching assistants is the least used, probably because the university does not have teaching assistants. Manage files, track students and track pages had the highest number of integration and renewal users.

Mail and discussion board are the most used and interactive whiteboard and breakout rooms are the least used of the communication course tools. Student pages and mail had the highest overall number of users in the

integration and renewal levels. However, it is interesting to note that, under the stages of concern, non-users expressed concern that the communication/live conferencing tools are as effective as in face-to-face setting.

Stages of Concern

Of the 34 respondents, 9 were identified as “non-users” by their own self-assessment. To examine the stages of concern of those who identified themselves as “users”, the “non-users” were pulled from the data, and the responses of the “users” to the Stages of Concern questions were totaled and percentages were tabulated. The average percentages are illustrated in Table 2.

Table 2 Stages of Concern Responses (n=25)

Stage of Concern	Not True of Me Now	Somewhat True of Me	Very True of Me Now
“0” Awareness	1%	14%	84%
“1” Informational	16%	40%	44%
“2” Personal	22%	49%	28%
“3” Management	22%	43%	35%
“4” Consequence	40%	35%	22%
“5” Collaboration	26%	37%	37%
“6” Refocusing	41%	26%	33%

The participants in this study showed high levels of concern at the lower SoC. This indicates that the majority of faculty at this institution are in the initial stages of the change process. This is supported by their responses to the LoU questions.

Faculty Concerns by Level of Use

In order to determine patterns in the data, we grouped the participants based on their Levels of Use and then determined the levels of concern for each Stage. Figures 1-3 represent this data for each category of the course management system tools.

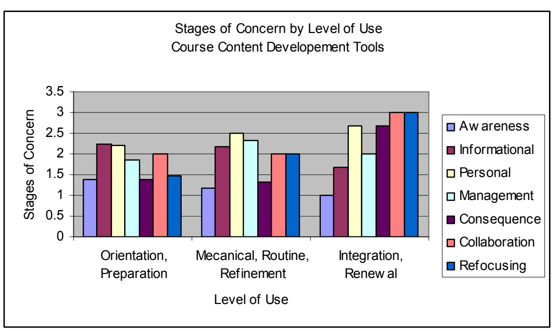

Figure 1 Course Content Development Tools

Participants representing levels of use from Orientation to Refinement for the content development tools appear to have higher concerns at the Informational, Personal, and Management SoC (Fig. 1). These responses could be attributed to concerns with the amount of time that is required to develop a course for online production. Because of the size of the university, few resources—in terms of support from research assistants, released time for course production—are available for faculty. These results are congruent with the outcomes of most CBAM assessments; that is, the higher the level of use the higher the level of sophistication of the stages of concern. Those participants at the Integration and Renewal levels of use clearly have stages of concern in the Collaboration and Refocusing areas. It is also interesting to note that, regardless of the level of use, the Personal stage ranks high. Again, this might be explained by the lack of resources and, therefore, the increased amount of time needed to perform the task.

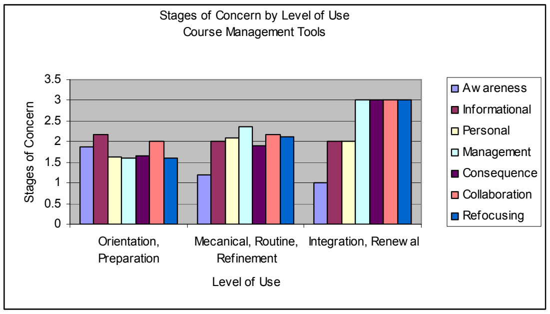

Figure 2 Course Management Category

Participants' responses on the Course Management category are fully in line with the expected outcomes. Individuals in the Orientation; Preparation; and Mechanical, Routine, and Refinement Levels of Use were similar in nature. Again, the participants in the Integration and Renewal Level of Use reported much higher stages of concern in Management, Consequence, Collaboration, and Refocusing (Fig. 2).

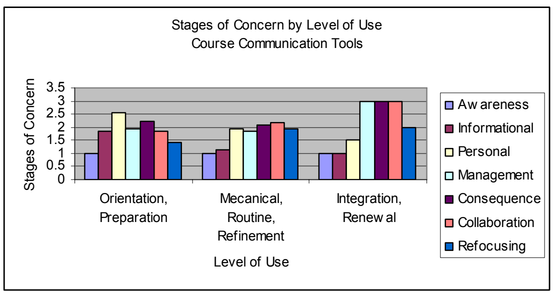

Figure 3 Course Communication Category

There was a distinct change in the levels of use for specific tools in both the course management and communication categories, but the overall concerns only showed a shift in the communication category. Participants' responses on the Communication category demonstrate a positive relationship where the concerns address the higher stages when the user is at a higher level of use (Fig. 3). Considering that only 3 of the participants reported five or more years of experience teaching web-based courses, the results suggest that it may take at least five years to move through the change process.

Discussion

The purpose of this study was to address four research questions. The first question was simply to determine what web-based course management tools faculty were currently using. As discussed above, the majority of the participants consider themselves to be at the Orientation or Preparation levels of use in all of the categories, with a few exceptions. More than fifty percent of those teaching one or more web-based courses demonstrate higher levels of use for some of the communication and course management tools. The tools include changing course settings, managing students and files, and mail and discussion. Interaction between faculty and students (and content) is lifeblood of the learning environment, so these tools must be used for successful teaching and learning in web-based courses. It was also noted that fewer faculty members participate at the Mechanical and Routine level of use when we look at the course content development tools category. The tools in this category may take longer to learn, and many find it faster and easier to transfer documents into the course files rather than create new content documents.

The second question addressed the types of concerns faculty have about using the tools of a web-based course management system. While specific concerns were addressed above, similar issues regarding use of personal time, lack of administrative support, and effectiveness of student learning were the major issues that faculty at all levels of use shared. Those participants in the Integration and Renewal levels were more concerned with the

limitations and lack of flexibility of the course management system. This is expected for any new innovation because the concern focus moves from personal use of the tools to the purpose and impact of using the tools for instructional purposes.

The third research question initiated this study. The figures 1-3 above clearly illustrate that a relationship does exist between the Levels of Use and the Stages of Concern. Those who frequently use more of the tools have concerns that involve higher stages of concern. Collaboration with other colleagues as well as interest in modifying, developing, or investigating new technologies became a higher priority than the lesser stages of concern. It was interesting to note that the participants in this study that have more experience (Integration and Renewal LoU) continue to have high personal concern in the course content category. Future research should be conducted to determine if this is unique to this pilot institution or if personal concerns about the development of course content in web-based teaching and learning is a wide spread phenomenon. Because the faculty at this LoU have five or more years of experience with teaching web-based courses, this should provide data that supports the need for ongoing faculty training and support.

The fourth research question—whether a faculty member's discipline, teaching experience, access to training, years of use, or other factors have an effect on that relationship—could not be addressed with such a small sample. However, this research project does validate the instrument as a useful measure to address faculty concerns. Future research should be conducted using the instrument with a larger sampling from multiple educational settings.

In conclusion, it was determined that concerns as a whole increased as the level of use increased. This fact supports the validity of the instrument used because the CBAM conceptual model identifies stages of concern based upon the interaction of the participants with the innovation. This study also supports the premise of the 1999 PT3 grant proposal, Shared Visions, that "long-term support is key to teacher change" (Hall, Fisher, Musanti, Halquist, Magnuson & Simmons-Klarer, 2002, p. 4). The need for strong support from administration with any educational change has been historically well-documented (Goodlad, 1968; Lieberman, 1973). This study also supports other studies which report the importance of adequate training for instructors and students (Storey, Phillips, Maczewski & Wang, 2002). Although the concerns may change, all levels of users have valid concerns that should be addressed as all stakeholders move through the change process. Many universities have basic training for use of web-based course management systems, but future studies are needed to determine how to address the concerns of faculty after they gain experience with the tools.

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The Effect Of Peer Feedback For Journaling On College Students' Reflective Thinking Skills

Ying Xie
Penn State University

Fengfeng Ke
University of New Mexico

Priya Sharma

Abstract

Moon (1999) proposed that it is through reflection that we make meaning of new information and the environment and advance from surface to deep learning. The ability to thinking reflectively has been advocated as one of the educational goals in schools and colleges (Dewey, 1998). However, because of its complex and elusive nature, researchers and practitioners have found it difficult to engage students in this process. Various strategies have been recommended for encouraging reflection, such as portfolios(Wade & Yarbrough, 1996), socratic questioning, journal writing, Interpersonal Process Recall (IPR), and reflecting teams (Griffith & Frieden, 2000). In addition, peer feedback was found to promote deep thinking and critical thinking. This study aims to investigate the effects of peer feedback for journaling on college students' reflective thinking skills. Forty-four first- and second- year undergraduate students in a northeastern land-grant university participated in the study. However, only 27 students kept journals consistently. This study employed an experimental design with one control group and one treatment group. Two journals were sampled from the first half of journal entries and the second half for each student and a repeated measure one-way ANOVA was performed to analyze the data. Statistically significant results were found that students' reflective thinking level increased over time but peer feedback affected negatively on students' reflective thinking skills demonstrated in the journals. The result of the study indicated that the use of reflective journals promoted students' reflection as shown by previous studies. However, peer feedback's adverse affect on their reflection suggested more careful use in the future.

Introduction

Role of Reflection in Learning

Based on his observations of his own thinking process and of others', Dewey (1933; Dewey, 1998) made a seminal contribution by giving a detailed account of how we think. Building on Dewey's work, many other theorists continued to propose their own models (e.g. Kolb's (1984), Schön's (1983), Mezirow's (1991), and King and Kitchener's (1994)). Moon (1999) defined reflection as "a mental process with purpose and/or outcome in which manipulation of meaning is applied to relatively complicated or unstructured ideas in learning or to problems for which there is no obvious solution" (p155). In order to illustrate the role of reflection in learning, she proposed a hypothetical model, called "a map of learning," that synthesized the theories of cognitive structure, Piaget's theory of assimilation and accommodation, stages of learning (similar to information processing theory), deep/surface learning, and best possible representation of learning (BPR):

Moon identifies learning as a cycle of assimilating information, building cognitive structures, and accommodating new information and cognitive components. Each cycle starts from people taking notice of new information, then making sense, making meaning, and working with meaning until transformative learning. Each stage of learning results in some amount of upgrading of the BPRs in the learner. "It has been suggested that stage of learning reached at a given time determines the maximum (best possible) quality of representation of that learning." (Moon, 1999 p147).

Scholars seem to agree on a pyramid-shaped model of reflective thinking, which divides reflective thinking into three modes or levels: technical, contextual and dialectical (Taggart & Wilson, 1998). Mezirow (1991) differentiated three categories of reflective thinking: content, process and premise reflection. The common belief of

the previously cited models is that the degree of reflection is a function of how much of the schema or cognitive structure is used or changed. When past experience only flashes through the mind, the learner is not involved in deep levels of reflection and the representation of the thinking process (if there's any) will be mostly descriptive. Doubtful situations trigger reflection (Dewey, 1933), and we can hypothesize that reflection serves to accommodate new information and minimize the "disequilibrium" in learners. During the process of examining past experiences, if the learner finds a problem or doubt, his or her thinking deepens. Thinking can be further more reflective when the learner begins to contextualize thinking to find the cause and effect of the situation. If the learner questions his or her premise, begins to tolerate individual differences, outgrows egocentrism and moves to exocentrism, and broadens thinking into a larger (such as sociopolitical) context, his/her schema is used to a great extent (Moon, 1999). This idea of different levels of reflection is in harmony with Moon's model since she stated that extensive reflection by the learner will not only make meaning but modify the cognitive structure so that his/her schema is used or changed to a large extent.

Since reflection is an effortful action, previous research has indicated that students find it difficult to engage in reflection over extended periods of time without external support (Harri-Augstein & Thomas, 1991). It has been found that most college students are involved in "quasi-reflective" thinking as their reflections usually stop at the lower level (P. M. King & Kitchener, 1994). Various strategies have been recommended for encouraging reflection. Among them, journal writing was identified as an effective way to promote students' reflective thinking skills because it offered a means by which students can externalize their reasoning and reflections on experiences (Stickel & Trimmer, 1994) and then reframe experiences within the learning context (Andrusyszyn & Davie, 1997). Journaling has become a popular technique that is both found to promote reflective thinking skill (Griffith & Frieden, 2000; Hiemstra, 2001; Jasper, 1999; Kerka, 2002; Keys, 1999; Priya & Xie, 2005; Spalding & Wilson, 2002) and used to assess it because journals provide "evidence" of whether or how reflective thinking skills are used (Bourner, 2003; Wood & Lynch, 1998).

Although some research has been conducted in this area, no specific research has investigated the use of additional strategies to help scaffold reflection through journaling. For example, Moon suggests that working with others can facilitate reflection. And Boud (1999) explicitly mentioned that working with peers instead of someone who were presumably "superior" such as mentors or teachers can help reflection.

Peer-based Learning

A "critical friend" is said to promote reflective thinking skills. Moon (1999) illustrated as follows:

> "working with others can facilitate learners to reflect and can deepen and broaden the quality of the reflection so long as all the learners are engaged in the process. Another person can provide the free attention that facilitates reflection, ask challenging questions, notice and challenge blocks and emotional barriers in reflection." (p172).

If the critical friend is involved in another person's relatively individualized journaling process by providing constructive feedback, both parties will have opportunities of seeing different perspectives, which may influence or fundamentally change the way they assimilate and accommodate information. No two persons have had the exact experiences; therefore their cognitive structures are expected to be different. When two people's making- and working-with-meaning processes are so closely intertwined, they may feel the need to modify their cognitive structure not only to accommodate new information but also to tolerate individual differences. If the two people start with different values or worldviews, it is possible for an overhaul of the structure to take place, which is called "transformation" by Mezirow (1991).

Boud (1999) compared peer learning with mentoring on the possibility of engaging in reflective thinking, commenting "there are increased possibilities for participants to engage in reflection and exploration of ideas when they are not in the presence of someone designated as a 'teacher'". It was found argumentation facilitates reflection. For instance, Blumenfeld, Marx, Soloway, & Krajcik (1996) stated that discourse in online forums encourages "delayed reflection". Eisen (2001) studied the role of peer based learning in professional development from the lens of transformative learning defined by Mezirow. She found that "relationally based activities" including peer dialogue and feedback sparked individual and joint reflection. Findings in these works were mostly observations or reflections researchers made after the experiments were completed. Empirical studies are lacking which directly probe into the role of peers on learners' reflective thinking process.

Research Questions

The current study aims to look into the effect of peer feedback for journaling on college students' reflective thinking skills. The research questions are:

- Will students who give and receive peer feedback on their journals exhibit higher levels of reflection than those who do not give or receive such feedback? (the null hypothesis is: student who give and receive peer feedback on their journals will not exhibit higher levels of reflection than those who do not give or receive such feedback and the alternative hypothesis is: student who give and receive peer feedback on their journals will exhibit higher levels of reflection than those who do not give or receive such feedback)
- Does the students' reflective thinking level differ over time and how?

Method

Participants

Two sessions of the same class with about 70 undergraduate students at a northeastern land-grant university were contacted for the study. 44 students signed up for the study but only 27 of them kept journals for the entire study span. The data of the rest of the students were deleted from this study.

Procedure

Each student in this class was randomly assigned to two groups: control and treatment groups. The control group kept journaling for one semester without peer or instructor input or feedback. For the treatment group, students were paired and they kept journals for a month as well as responding to their paired peer's journals. A peer-feedback guide was given out at the beginning of the study. All groups were taught by the same instructor and the in-class activities were same for all groups. For both groups, the cognitive structure/guideline were given out to the students in the "structure" groups at an information session at the beginning of the semester, detailing the five phases of thinking proposed by Dewey (1933). Students were asked to write at least one journal every week. Two samples were randomly collected from each student's journals, one from the first half semester, the other from the second half.

The "coding scheme of reflective process" was used to score the reflective journals (Frances et al., 1995). It was chosen because it has 6 levels and allows for more gradation in scoring. Two raters coded the journals. After reaching 100 percent agreement on scoring the first 10 blog samples, raters double-blindly scored the reflective journals of the rest sampled journals. The interrater reliability was 83%. The average score of both raters' grading is used for data analysis.

Result

A repeated measure ANOVA indicated no interaction effect between treatment and time. For the control group who were not involved in peer feedback, students' mean score on reflection increased by 1.04 point after a semester of keeping journals; however, for the treatment group who received and wrote feedback, students' score increased by .93 point over time.

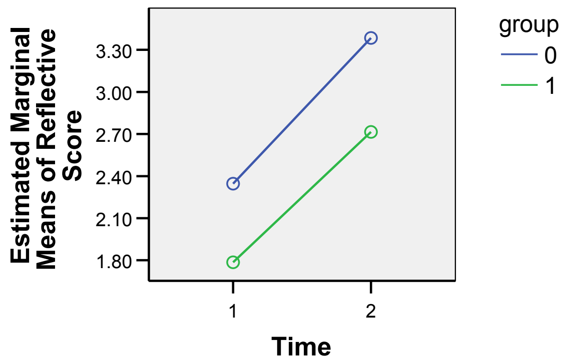
Table 1 shows the mean reflection scores for both groups in two samplings and the differences of reflection scores for both groups over time. Figure 1 shows no observed interaction effect between the treatment and time.

Table 1 Mean reflection scores and standard deviation for two samplings and their differences for both groups

Group	N	First sample	Second sample	Difference
Control	13	2.34 (.69)	3.38 (1.21)	1.04
Treatment	14	1.78 (1.01)	2.71 (.96)	.93

Note: Standard deviation in parenthesis

Figure 1 No observed interaction effect between treatment and time



The following table shows the analysis of variance for the relationship of time and group for their reflective thinking score.

Table 2 Analysis of variance for the relationship of time and group for their reflective thinking score

Source of Variation	SS	df	p-Value
Model			
Time	13.04	1	.000*
Group	5.10	1	.028**
Time*Group	4.07E-02	1	.809

Note: * statistically significant at the .001 level; ** statistically significant at the .05 level

The interaction effect between time and group is not statistically significant. This means that in the population, the effect of group (feedback or non-feedback) on students' reflective thinking scores won't be different for the first half or the second half of the semester. And also, the effect of time on students' reflective thinking scores won't be different for students who are sending and receiving feedback or not sending or receiving feedback.

Table 3 Interrelationship between time and reflective thinking score

	Mean	Std. Error
First-half semester	2.07	.168
Second-half semester	3.05	.209

Note: F=19.09, p=.000

The main effect of time on students' reflective thinking scores is statistically significant at .001 level. In the population, as students keep blogging, students tend to be more reflective as time passes by (3.05 vs. 2.07).

Table 4 Interrelationship between group and reflective thinking score

	Mean	N
Feedback group	2.25	13
Non-feedback group	2.87	14

Note: p=.028 for one-tailed test

The main effect of different feedback group on students' reflective thinking scores is statistically significant at .05 level for the one-tailed test. In the population, students who send or receive feedback on their weblogs tend to be less reflective than those who do not send or receive feedback (2.25 vs. 2.87).

For the first research question, the null hypothesis is retained (student who give and receive peer feedback on their journals will not exhibit higher levels of reflection than those who do not give or receive such feedback). In fact, the results showed that contrary to the alternative hypothesis, student who give and receive peer feedback on their journals exhibited lower levels of reflection than those who do not give or receive such feedback and this difference was statistically significant.

As for the second research question, it was found that if students kept journaling, their reflective thinking level increased over time--the exhibited reflective thinking skill of students increased equally for both groups from the first to the second half of the semester.

Discussion

The present study investigated the extent to which using peer feedback on college students' journaling could change their reflective thinking skills. The result showed all students improved in their reflective thinking skills as time passed by. However, the students who were involved in solitary journaling demonstrated higher level of reflection consistently over time than those who sent and received feedback. The differences were statistically significant.

As many researchers have pointed out that when students are required to journal for their coursework or field of study, the link between learning experiences and reflective activity could be strengthened because "a specific allocation of time which can be used for reflection" is incorporated (Boud, Keogh, & Walker, 1985). Britton (1978) identified the role of writing in the reflecting process as allowing students to switch roles between participants and spectators of their own thinking. When students are writing, in order to produce an articulate statement they need to first construct ideas in their mind—the meaning making process in Moon's model. Then when students pause and become readers of their own writing, they have another chance of speculate on these ideas and test their viability according to their existing schema. In order to articulate their ideas, students assume roles of participants and readers so that the "learning and the representation of the original learning both occur" at any time in Moon's model. Since the representation of the learning is available to the learners, the workload in their working memory will be greatly reduced. Therefore, students can better engage in their learning—making and working with meaning. The findings of the study confirmed that if students are constantly engaged in journaling activities, their reflective thinking level demonstrated by their journal entries would increase over time.

Contrary to the prediction of previous research findings, peer feedback did not promote students' reflective thinking skills when combined with journaling. Although students were randomly assigned to different feedback groups, the students in the feedback group constantly showed lower reflective thinking level than those who were journaling in a secluded manner. Peer feedback seemed to have counteracted the effect of journaling. There could be two reasons that had caused the problem: first, journaling is a self-introspective process, when people are journaling, they can be distracted or interfered by the fact that their writings will be looked at by some other people and they might have refrained from journaling something they thought other people wouldn't understand or maybe laugh at. Research found that individuals wrote something "presentable" and "sense-making" when they knew that there was a good chance that other people would read them (Xie & Sharma, 2004). They deliberately avoided "babbling" what was on their mind. Instead, they adopted a more conservative approach to journal. The second reason was that it seemed students did not engage in a meaningful feedback activity as was found by a closer look at their comments to each other. The students in the treatment group were paired. It was found that if one of the pair didn't demonstrate higher level of reflective thinking in their journals, it was very likely that the other won't engage in higher level of reflective thinking either. It seems to be a reciprocal adverse effect on their attitude toward reflection from peers. Previous researchers (Slavin, 1990, 1995) pointed out that peer feedback on journaling should be moderated to reduce off-track and passive behaviors in interactive discourse, and that structured protocols should be used while ensuring opportunities for equal participation and a "trusting and non-threatening relationship" among peers (Eisen, 2001). In addition, structured peer learning improved academic achievement and boosted student attitudes (A. King, 2002; Zhang, 2004). Bonk and his colleagues identified four "key action areas" for instructors' moderation (Bonk, Kirkley, Hara, & Dennen, 2001). They consist of pedagogical, social, managerial and technical actions. The pedagogical role requires the instructor to e.g. ask questions, provide feedback, probe etc. The social role involves creating a friendly environment and offering affective support. The managerial actions can include designing and coordinate assignment and overseeing tasks and course structure and requirements. The technical role includes actions such as assisting the use of technology.

This study has found that beyond instructors' moderation on the feedback, it could also be helpful if scaffolds could have been provided by the instructor about how to find topics to journal about for the first-year college students. The researcher found that some students did not understand what reflection was and how this strategy could help them in their study. Although students were given a short information session about how to reflect, most students were unsure how to implement their reflection. As a result, many students either recounted what they read or learned in class or commented on the way the instructor conducted the class. Even as their reflective thinking scores increased over time, their average score by the end of the semester was only 3.05 out of 6 (the highest possible score of reflection with the coding scheme used in this study). It was indicated in research that

self-selected topics in journaling made graduate students question the learning content more deeply because students are perforce engaged in finding the trigger for a “doubtful” situation while trying to identify a topic to write about (Xie & Sharma, 2004). However, a lot of lower-class college students are not cognitively ready to find the trigger by themselves without any help from the instructor. It is recommended that in future studies scaffolds should be offered that focus students on the key points of the new learning and contain prompts for them to mentally scan existing cognitive structure in an attempt to find conflicting ideas.

The ability to think reflectively is germane to learning in that it makes learning meaningful. Efforts should be intensified to identify cost effective and feasible ways to improve this indispensable skill. The present study can serve to provide some insights about how college students make uses of journals and peer feedback. More research is needed to advance our knowledge of finding scaffolding strategies for both peer feedback and journaling to promote reflective thinking skills.

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Monitoring Sokoban Problem Solving: What a Case Study Implies for Metacognitive Support for Game-based Problem Solving?

SungAe Yoo
Ronald Zellner
Texas A & M University

Abstract

This case study analyzes the cognitive process underlying a teenager's Sokoban problem solving within the framework of major learning theories. The effects of metacognitive inquiries and self-correction on latency in completing the game were examined. A major finding was that the gamer employed both forward- and backward-working strategies and tended to use a start-all-over-again strategy when faced with an impasse. Implications that support a game-based problem solving approach were also discussed.

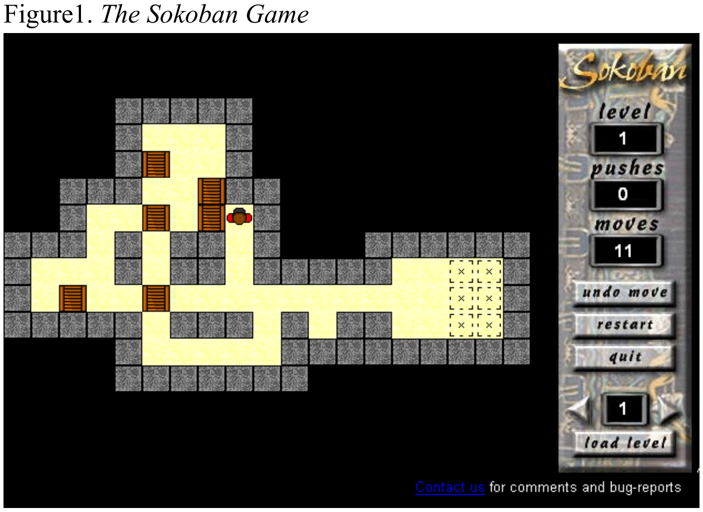
Introduction

What goes on a gamer's mind working on a play?

Game-playing was suggested to enhance young learners' critical thinking and problem-solving skills (Katz, 2000; Prensky, 2000). Over the past years, a great deal of attention has been paid to games as a powerful learning mechanism which goes beyond just a delivery context of content (Squire, 2005). However, there appears to be lack of research focusing on how game-playing boosts learners' critical thinking or problem solving skills. From a pedagogical perspective, it is critical to understand how learning occurs while young learners are engaged in problem solving given in a context of game play in order to provide them more timely and effective support for their learning. Consequently, the knowledge gained through studies about young learners' thinking via game play over a computer may allow us to anticipate potential obstacles that individuals may face in the problem solving process, thus making it possible to prescribe timely support for solving such problems.

Moreover, game-playing in a computerized setting is likely to demand different cognitive and metacognitive controls from the conventional, paper-pencil, problem solving approaches. Tracing a learner's thinking as well as learning processes in a computer game format of problem solving may disclose many unique aspects of cognition. From such a viewpoint, this study was intended to examine a 13-year-old boy's Sokoban computer game playing. The focus was on following the participant's flow of thinking while he was working on the game.

Figure1. *The Sokoban Game*



In Sokoban, a player acts as a person who must push a number of crates through passageways to a final destination area. The goal is to use minimum number of pushes. The player can only push one single crate at a time in one direction, and is not able to pull crates. The gamer can use Undo and Restart buttons when desired. Inevitably, the player faces an impasse; there is no way out. The game has a total of 20 levels, each level has an ascending level

of complexity. Given the design and rules required, Sokoban provides an ideal training context for self-directed problem solving. Sokoban is available for free at www.pimpernel.com/sokoban/sokoban.html.
Studies have shown that a learner's metacognitive and adaptive self-correction of cognitive strategies enhance self-regulated learning (Butler & Winne, 1995; Zimmerman, 1989, 1994). Based on this idea, this study also examined how the learner's guided metacognitive visualizing of his own thinking process impacted his learning process. Metacognitive visualization referred to encouraging a learner to externalize orally and graphically his/her use of strategies or rules which led to either a success or failure and adaptively providing corrective feedback. This process was believed to aid the participant's self-regulated monitoring of his learning process. Implications for support of young learners' developing problem solving ability in a game-based learning environment were also explored.

Theoretical framework

Problem Solving Stages

Problem solving generally undergoes the following four stages: representation of the problem, searching the problem space, evaluation of the solution, and application (Gagne, Yekovich, & Yekovich, 1993). Problem representation in the first stage includes defining the problem and exploring the required conditions of the given problem. Searching the problem space, the second stage, refers to exploring the ways that lead to a solution to the problem. In this stage, the problem solver may attempt to find a clue for the solution by trying to recall prior experiences of problem solving that were similar to, or associated to some extent with, the current problem. In the evaluation stage, the problem solver judges a hypothesized solution to the criterion of the goal or solution. The problem solver will also evaluate whether the required conditions are met by the solution he hypothesizes. In the application stage, the problem solver applies prior learning to a novel situation of problem solving. Although problem solving is generally described as a sequence of stages, problem solving would not necessarily always occur in the same sequence(Gagne, Yekovich, & Yekovich, 1993). It is assumed that a problem solver working on Sokoban goes through all stages of problem solving but the sequence would not be linear.

Procedural Knowledge Processing

Cognitive psychologists claim that the goal and sub-goal relations among productions (If-Then) promote the control of cognitive flow from one production to another within a given production system (Gagne, Yekovich, & Yekovich, 1993).

It appears to be almost impossible to get direct observation on how a person processes procedural knowledge based on any data obtained from the traditional paper-pencil assessment tools. In a problem solving scenario utilizing a game format, if the interaction process between the problem solver and a problem is recorded, the building process of procedural knowledge can be examined. In addition, the problem structure of the game may demand multiple layers of goal setting and decision making through the course of exploring a solution. The learner will not only attempt to recall the existing procedural knowledge to relate to the current problem but also create procedural knowledge that serves to identify a solution to the novel problem. In this analysis, the focus was the examination of the ways in which the gamer formulated goals and sub-goals during the game-play. Considering that Sokoban problem solving does not provide a specific goal state, the process of goal setting and goal-directed decision making are totally at the player's discretion.

Problem Solving Strategies

There are general strategies to guide exploring a solution in problem solving such as trial and error, means-ends analysis, and reasoning by analogy. Recent research findings have suggested that domain-specific strategies are also crucial for success in problem solving. Domain-specific knowledge helps construct a schema that "allows problem solvers to recognize a problem state as belonging to a particular category of problem states that normally requires particular moves" (Sweller, 1988, p. 259). Thus, possessing sophisticated schemas is an essential criterion on which an expert is distinguished from a non-expert. According to Sweller (1988), experts tend to employ more forward-working strategies than back-ward working (means-ends) strategies, which is attributable to their well-established knowledge structure in the form of schemas.

Sweller and Levine (1982) found that non-specific goals permitted more rapid learning of essential structural characteristics than providing a conventional goal. It was argued that in the conventional goal-directed learning settings the students had difficulty inducing the relevant rule without implicit or explicit additional information provided. According to Sweller (1988), learners use heuristics, such as means-ends strategies, in conventional goal-directed learning settings. The use of heuristics, consequently, interferes with "learning essential aspects of a problem's structure" (p. 4). Sweller also empirically showed that problem solving with a specific goal

demands relatively large amounts of cognitive resources, thus resulting in additional expenditures of cognitive processing capacity required for constructing schemas.

From Sweller's perspective, a Sokoban problem solver was expected to discover both goals and methods for the play, relying mostly on a forward-working strategy because Sokoban does not have any specific goal statement. Considering that the participant in this study was new to Sokoban problem solving, he was anticipated to work forward without being controlled by a schema, simply exploring the problem space in order to see what moves were possible. (Sweller, 1988).

Learners' uses of cognitive strategies are likely to be influenced by the structure of a problem as well. Sokoban has a unique problem, structure and context; it has simple game rules and is played on a computer screen. As a computer game, Sokoban has a feature that the conventional paper-pencil problem solving does not have. In Sokoban a move made acts as a quick, visual clue for the following moves. For example, a wrong move would cause immediate, negative feedback to the problem solver because the wrong move inhibits any further action, which can inform the problem solver that his action intended was wrong. Sokoban is designed so that the problem solver inevitably arrives at many dead-ends. In this study it is also of interest to see what kinds of strategies benefit the gamer when put in no-way-out situations.

Metacogniton and Metacognitive Visualizing

According to Flavell (1979), metacognition is "knowledge and cognition about cognitive phenomenon"(p. 906) and involves deliberate, intentional, and goal-directed mental operations. Metacognition comprises two related aspects: understanding what kind of skills, strategies, and resources a task requires and knowing how and when to use the skills or strategies to ensure the task is successfully completed (Schunk, 2004). Studies indicate that regulatory strategies to accomplish specific learning goals are positively related to self-regulating ability (e.g. Printrich, 2000; Zimmerman, 2000; Schunk, 2001).

Problem solving such as Sokoban requires a relatively high level of self-regulated ability in monitoring progress, predicting outcomes, and evaluating the effectiveness of strategies or skills. Thus it was considered that through scaffolding, the participant visualizes ways to regulate the learning process or uses cognitive strategies to enhance his self-regulated problem solving skills.

Method

Participant

The participant in this case study was a 13-year-old boy. From prior conversation with the participant, he indicated that his weekly computer game playing totaled approximately five hours per week, mostly for entertainment purposes. The participant reported that he has never played Sokoban prior to his participation in this study. When he was questioned about other activities with his computer, he responded that he also uses his computer to complete homework assignments and class projects several times per week. Based on this information, it was regarded that the participant was relatively familiar with playing computer games, mostly entertainment types of games, and had fair experience in using a computer for his academic work.

About the Method

For the analysis of the thinking process of playing Sokoban, the classical 'thinking aloud' approach was used along with video- recorded monitoring. In applying these methods, the participant was asked to state aloud whatever ideas came to mind while playing the game.

The traditional method of 'thinking aloud' has a distinct advantage in that it allows researchers to obtain information not only about the final result of problem solving but also about the learner's thinking process which underlies the game playing. However this method has a limitation in that it demands dual cognitive duties from the participant. The participant has to work on the problem while simultaneously recalling from his memory what he has done in order to describe it orally. During this process, it's probable that the limited capacity of our short-term memory would not allow the participants to remember all ideas or thoughts that would come up while interacting with a problem.

However this limitation of the 'think aloud' method can be canceled out if the overall performance of the game player is recorded. On top of that, an audio-visual recording of the overall process of problem solving would be useful for timely locating the very points over the course of problem solving where the gamer is in need of any cognitive support. The computer screen and the learner's voice while playing were recorded. The recorded voice was transcribed for analysis.

Procedure

Two rounds of game plays were conducted. In order to examine the effects of scaffolding metacognitive visualization and guided self-correction of misconception or inefficient use of skills, the participant was intervened after the first session of game-playing. In the initial play, the player was directed to state aloud whatever ideas or thoughts come up with while playing. There was no restriction to the number of game levels that the participant can attempt up to a maximum of 20 levels. On the following day, the participant engaged in the second play.

Prior to the second game-plying, the participant was guided to visualize his thinking based on the recording of the initial game-playing and accordingly asked to self-correct misconceptions or inefficient use of strategies. The participant reviewed his recorded game-playing from the previous day, and was asked to respond to the following question: "Tell me some rules or strategies that you found useful for the game from the previous play". This question was intended to allow the learner to recall any conditional knowledge that he learned from the prior game-playing. It was assumed that answering this question would be possible when the participant figured out what conditions signify a success or a failure.

Then, the participant was also asked to illustrate patterns that might lead to a dead end, which was intended to help the learner regulate his own use of conditional knowledge to solve the problem. He was then asked to draw the patterns that led to a dead end in the previous play. Next, the researcher and the participant went back to the Sokoban screen and the participant was asked to make up situations that might be problematic. Finally, the participant was questioned as to why the situations that he created were puzzling to him. This question was intended to allow the participant to probe any misconceptions and use of inefficient strategies. In response to the answers from the participant, the researcher manipulated a few examples and non-examples of solution paths over the computer.

The second session of play was carried out in a condition identical to the initial play session with the exception of allowing an upper cap of the fourth level in order to equate the number of levels attempted between two game sessions. The difference on the completion level between two game sessions was examined. The details of study procedures are seen in Table 1 below.

Table 1. *Details of the Study Design*

	Session 1	Session 2
Interventions	No intervention.	Before beginning the game-playing, the participant a) was asked by the question, "Tell me some rules or strategies that you found useful for the game from the previous play and b) was requested to "Draw the patterns that led to a dead end in the previous play". After reviewing of the recorded, previous play, the participant was guided by an oral discussion and encouraged to self-correct his misconception or use of inefficient strategies.
Directions provided	The participant was asked to say aloud whatever ideas or thoughts come up with.	The participant was asked to say aloud whatever ideas or thoughts come up with.
Levels	No upper limit	The highest level was the fourth to match the final session

* Note: the second playing was carried out on the following day of the initial game-playing.

Results

Effect of Metacognitive Visualizing

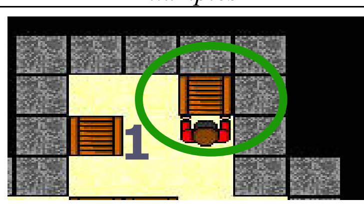
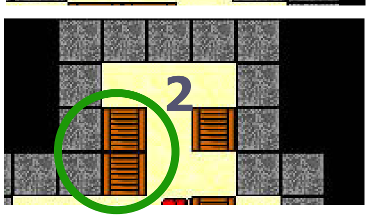
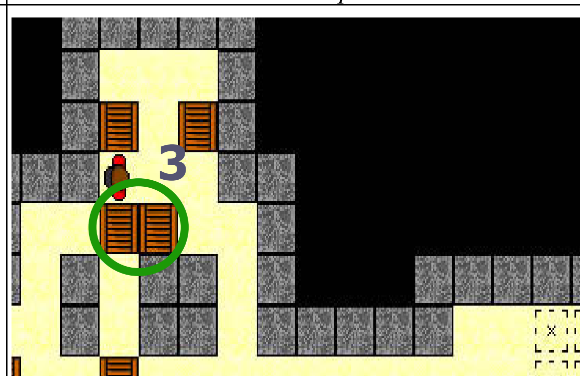
In the initial play, the player attempted the first four out of the total 20 levels for 24 minutes. The player completed only the first level out of the four attempted. On the other hand, in the second session of playing, the player attempted the first four levels for 28 minutes and completed all four levels attempted; specifically, in the first session, the player completed the first level, gave up the second level after several attempts, almost skipped the third level, and almost completed the fourth level. In contrast, in the second session of playing, the player was successful in completing all four levels within less time than that spent in the first session.

Table 2. *Summary of time spent and completion levels of two game plays.*

	Session 1 (day 1)	Session 2 (day 2)
Total spent time	24 minutes	28 minutes
Levels attempted	Level 1 to 4.	Level 1 to 4
Levels completed	Only the first level	All 4 levels attempted

Prior to beginning the second session of playing, the player responded to two requests. First, the participant was asked, "Tell me some rules or strategies that you found for the game from the previous trial." The player responded as the followings: 1) "Don't place the box in a corner"; 2) "Don't place two boxes side by side"; 3) Find the "four-way intersection"; and 4) "Think ahead". These responses showed that although the player ended up completing only one level of the game in the initial game-playing, he was able to discover the crucial rules and strategies for playing Sokoban in that session. . When asked, "Draw the patterns that led to a dead end in the previous trial.", the player graphically described multiple situations that he figured out as being problematic in his play. The descriptions showed that the player discerned most of the potential problematic situations. One misunderstanding concerned play patterns or rules that led to a dead end. The player might consider that 'placing two boxes side by side' is consistently problematic in Sokoban problem solving based on his statement, "Don't place two boxes side by side" as a rule for the play. Accordingly, a few situations of examples and non-examples of "boxes placed side by side" that leads to a no-way-out situation were modeled onto the Sokoban (see Figure 1).

Figure 1. *Illustration of Examples and Non-examples of the side by side situation leading to a dead end*

Examples	*Non-examples*
 	

* Although both picture 2 and 3 describe a 'side by side' situation, only picture 2 leads to a dead end. This was articulated to the participant to help his forming a correct concept about the rule.

Then, the participant was asked if all of those situations were likely to end up with a dead end. The learner could arrive at the correct response after actually performing a few moves for the situations on the computer. During the discussion, the participant indicated that anticipating a few moves ahead was a useful strategy to produce a successful result of the playing.

Based on the analyses of the video-recorded data, some commonalities and differences were examined between the two game sessions. Commonalities included: 1) At times, the player reminded himself of the rule of 'minimum moves' saying "Since I have to make as minimum moves as possible"; 2) The player arranged objects in a way to accommodate later moves, a strategy formed based on his prior, general game-playing experiences; 3) The player often employed a "start all over again" strategy when stuck; and 4) The player often applied what he learned from the previous level to the next level (e.g., the player attempted take a detour at the place where the obstacles resembled a four-way intersection in a new level of play). From this observation it was obvious that the player was regulating his own playing in order to make his move more efficient.

On the other hand a few differences were also observed between two play sessions. For example, in the second play session: 1) The player used the strategy of seeing a few moves ahead ('think ahead', in the participant's words. See Table 3 for details) more frequently; 2) The player spent more time at the beginning of a level and at the points of making any change to a move that was already made; and 3) A reduction in the number of dead end occurrences were observed. This result indicates that, with increased game playing experience, the player relied more on the forward-working; additionally, his use of skills became more automatic, in which it can be assumed that he had formed schemas for playing Sokoban.

Analysis of the Recorded Game-playing

<u>Use of General Problem Solving Strategies</u>

It was found from the two trials of game-playing that the participant used both forward- and backward-working strategies of problem solving. In the first game playing session, Level 1, the participant appeared to engage in forward-working from time to time, as evidenced by the occurrences in which he reminded himself of the 'global goal', moving all the objects to the destination location, and the general game rules such as only pushing and minimum moves:

> My goal is to get all these boxes into six stacks on the right...I have to get the boxes to the four way intersection [the place where the array of the obstacles takes the shape of a four-way intersection on a road]….I have to make as minimum moves as possible…

At the same time he repeated trials and errors and often arrived at a no-way-out situation before finding a solution path. Backward-working strategies were also observed in instances when, for example, he evaluated whether his moves had been working or not based on the rules that he figured out for himself. In Sokoban playing, such autonomous evaluations of the game player appeared to be promoted by the immediate visual feedback given by the consequence of an action, which is clear from the following statement of the player:

> I will try this one…I am stuck again. I am not going to try with that box any more… I need to try to move with something else….Oh I got an idea….If I move one more step, I will be stuck. Oh I got it… I messed up. I am going to try all over again.

It was also found that the player figured out by himself essential rules for the game play from the early stage based on the following statement, "I have to get the boxes four-way intersection" A four-way interaction is located in Table 4, in the area labeled 1.

As he obtained more skills, he employed more often forward strategies, visioning ahead a set of moves. At the start of Level 2 in the second session, he stated, "I have to try to get this one out and then I can come back the other way. Then, this box should be in the intersection." (See the figure in Table 4 below).

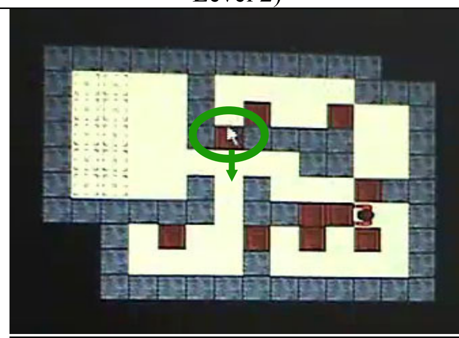
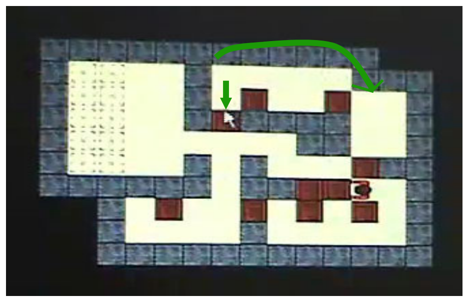
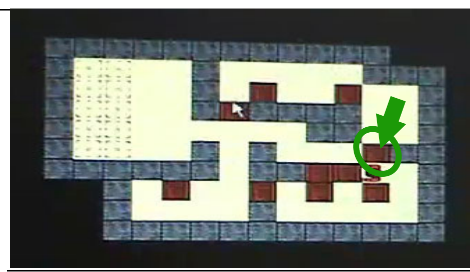
<u>Use of Domain Skills and Strategies</u>

In Sokoban, as true for many other game plays, the participant was not pre-trained with uses of skills or strategies that were useful for the game. The participant was entirely left to discover the rules or skills through his game-playing. As the participant played more levels, use of strategies was more often observed, indicating that the participant's level of understanding was increasing with time. The player used strategies such as 'think-ahead', 'taking a detour', 'minimum moves', and 'start all over again'.

'Think-ahead,' as named by the player, was commonly observed in this game play. 'Think-ahead' strategy was apparent based on the participant's statement in the second session, in which he stated, "I have to try to get this

one out and then I can come back the other way. This box should be in the intersection." Thinking ahead often involved the detour strategy as seen in the table 3.

Table 3. *Elaborations of the participant's use of the 'Think-ahead' strategy*

Statements	Graphic Elaborations (Second Session, at the start of Level 2)
"This box should be in the intersection."	
"…and then I can come back the other way."	
"I have to try to get this one out"	

It was clear that the player was intentional in employing the 'think ahead' strategy in an effort to make his actions more successful. This indicated that he was taking a metacognitive control over his Sokoban game-playing. In using this strategy, the player's oral reporting appeared to influence him. Saying loud what he has on his mind while playing the game probably facilitated his planning a few steps in advance and thus reinforced his use of the 'think ahead' strategy because he possibly recognized that the strategy was useful to prevent an incorrect path.

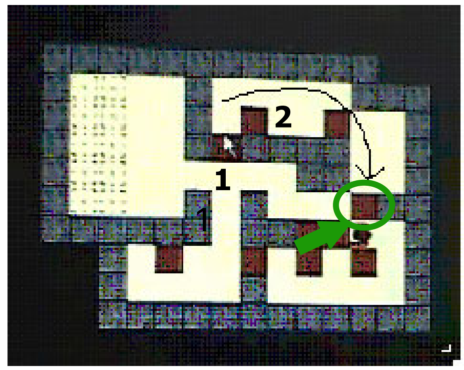
The player also attempted to make 'minimum moves' if possible. From time to time, he reminded himself of this rule, saying, "I have to make as minimum moves as possible." Although this 'minimum moves' rule was offered as a game rule at the outset, the player appeared to utilize this strategy in an attempt to save his cognitive efforts as well.

The player also often played the game from scratch by pressing the reset button, which action was referred to as 'start all over again" by the player. This 'start all over again' was used whenever the participant recognized 'no way out', which is obvious from the following statement: "If I move one more step, I will be stuck. Oh I got it… I messed up. I am going to try all over again." The player's multiple applications of this strategy over different game levels showed that the game player had acquired the pertinent conditional knowledge; that is, knowing how and when to use the skill or strategy to ensure optimal performance.

Developing Procedural Knowledge

Analyses of Sokoban game-playing with ‘think-aloud’ strategies provided a snapshot about how a game player obtained procedural knowledge. In this study, the problem solver developed procedural knowledge based on the game goals that were discovered by the player himself rather than provided externally. In Table 4, the development of player procedural knowledge is further elaborated.

Table 4. *Elaboration of production development –related to Table 3*

If the sub-goal is moving the crate (with the white arrow) to the destination area **Then** I have to put the target crate into the location of 1. **And then** I have to go way back (arrow 2) in order to push the target crate into the destination area. **If** the sub-goal is to move the crate with the white arrow to the place of 1 and go around back to the location of 1 to push the target crate into the destination, **Then** I need to get rid of this crate (pointed by the green arrow) first.	

Forming procedural knowledge was evidenced generally after the player failed in his repeated attempts to find a solution. Thus, it was regarded that producing procedural knowledge was also kind of a strategy that the player employed in an attempt to recover, an anticipated difficulty in the course of problem solving. Based on video recording of game playing, it was obvious that the development of the participant’s procedural knowledge increased and became more automatic as the total time engaged in Sokoban playing increased.

Conclusion

In this study we analyzed how a young game player learns and uses skills or strategies to play the Sokoban computer game. The focus was on the player’s metacognitive control over his thinking processes to complete the game. In addition, the effect of the player’s metacognitive monitoring and adaptive self-correction of misconceptions or ineffective uses of strategies for the game-play were also examined.

Based on the comparison of the two sessions of game-playing, it was discovered that the participant benefited from monitoring and visualizing his problem solving process and guided self-correction of misconceptions. In order to separate the possible practice effect from the intervention, further studies may include a control condition including multiple subjects or additional game-playing sessions. These findings imply that helping a problem solver monitor his learning and to recognize the efficient and inefficient use of skills or strategies is an effective pedagogical method. This study also corroborates the findings of Schunk and Swarts (1993), who suggest that young learners need feedback to apply strategies in order to improve their problem solving skills.

Two trials of game-playing indicated that the participant used both forward- and backward-working strategies. The backward-working strategy was also observed within a forward-working strategy. Sweller (1988) once categorized forward-working strategies. A schema driven approach used by an expert is a common example of a forward-working strategy. Further, forward-working strategies can occur during means-ends analysis. The problem structure, which has a non-specific goal, can lead to more forward-working (Sweller, 1988). Therefore, forward-working strategies were observed in this study and appeared to be related to the structure of the Sokoban play that had a non-specified goal. As expected, it was observed that as the problem solver gained more expertise over time, his process of playing became more automatic. This suggested that the player had obtained schemas of Sokoban playing. Obtaining schemas of Sokoban game playing were clearly seen in this study, based on the participant’s use of procedural knowledge. The participant also used backward-working strategies such as means-ends analysis and trials and errors. It is probable that the participant began working forward with the non-specified game goal and without prior experience of Sokoban playing, thus simply exploring the problem space in order to see what moves were possible (Sweller, 1988), without being controlled by a schema. However, when he encountered a

difficulty, he seemed to employ more of the means-ends analysis. This potential relationship between difficulties and use of backward-working strategies may be tested in future studies of problem solving with computer games.

It was also observed the player used domain-specific strategies such as 'think-ahead', 'taking a detour', 'minimum moves', and start all over again'. He seemed to consciously use such strategies as ways to make his moves more successful, which indicated that the player kept on monitoring his metacognitive control over his problem solving process. The method of 'think-aloud' was utilized to reinforce the player's use of strategies. The demand of speaking about his work processes possibly encouraged the participant to think about a set of moves ahead and finally helped the player learn that those strategies were useful.

Based on the recorded data, the participant was also observed to form procedural knowledge in the event he perceived a difficulty in finding a solution. Thus it seemed that the player who was working on Sokoban produced procedural knowledge in part as a strategy to overcome the difficulty in problem solving. This aspect also confirmed the work of Schunk (2004) that, "young learners are more likely to monitor their activities on tasks of intermediate difficulty as apposed to easy tasks"(p. 193).

As a case study, this study has a few limitations. One limitation is that the results may not be generalized with other participants, or other types of computer games. This study includes only one participant; therefore, the findings may be only relevant to similar ages or developmental levels; simply put, the findings from this study might not be consistent with learners at different levels of cognitive ability, computer experience, or motivation. In future studies the effects of such variables may be tested to take into further account learner variables. Second, in this study, the Sokoban computer game play involves only one gamer without any specific goal statements built-in. The findings of this study may vary with other types of game-playing in terms of the number of players, degree of entertainment, type of reward, and difficulty. Futures studies may take into account these task variables and test effects of such variables with both Sokoban and other types of plays. In addition the results from this analysis imply that Sokoban game-playing can be useful in studying cognitive and metacognitive thinking process.

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Effects of Direct Manipulation and Animation in Questions and Feedback: What's the Fuss?

Li Zhu
United States Naval Academy

Abstract: *This quantitative research investigated the instructional effects of different questioning and feedback strategies. Five treatment groups included: no questions and no feedback control group, traditional matching questions with Knowledge of Response (KOR) text feedback, traditional matching questions with KOR text plus animation-elaborated feedback, direct manipulation matching questions with KOR text feedback, and direct manipulation matching questions with KOR text plus animation-elaborated feedback. Participants were 184 college student volunteers. The study included an online pretest, followed by the web-based treatments and three online criterion tests. Two-way multiple analysis of covariance (MANCOVA) was used to analyze the data. Important findings included: (1) traditional matching questions were equally effective as direct manipulation matching questions in facilitating factual, conceptual, and rules and principles learning; (2) traditional matching questions were more effective in facilitating learning difficult concepts than no questions; and (3) no feedback, KOR text feedback only, and KOR text plus animation-elaborated feedback were equally effective in facilitating factual, conceptual, and rules and principles learning.*

Questioning and feedback strategies have long been considered very important and effective instructional strategies. With the development of computer technologies and new software capabilities, it is now possible to provide various innovative, engaging, and interactive questioning and feedback strategies in CBI (Computer-Based Instruction). Many instructional designers and educators have been using direct manipulation as a questioning strategy and animation as a feedback strategy, however, the effectiveness of these two instructional strategies on learning is not yet fully understood.

Direct manipulation questioning strategy allows learners to directly drag and drop screen objects to answer questions. The direct manipulation interface gives the learner the feeling of directness which shortens the distance between the learner's intentions and the physical facilities provided by the system, as well as the feeling of engagement (Hutchins, Hollan, & Norman, 1985). Although it seems that direct manipulation questioning strategy is very promising and innovative, further research needs to be conducted to find out its instructional effectiveness on student learning.

Animation, because of its unique attributes, is often used as a part of the practice strategies in CBI. When used in the most structured practice activities, animations were used as feedback to student answers providing reinforcement to correct answers (Rieber, 1990). Advances in technologies make it possible to enhance the quality and type of feedback generated in response to learner's actions by integrating animation. However, the effectiveness of animation feedback strategy in instruction still needs to be determined.

Review of the Literature

Theoretical Framework

Information processing theory, levels of processing theory, dual coding theory, and generative learning theory provide the fundamental theoretical framework for this study.

Information processing theory explains how people perceive, encode, and retrieve information. Direct manipulation matching questions and animation-elaborated feedback that match cognitive processing requirements of three levels of learning (factual, conceptual, and rules and principles) were expected to better facilitate the rehearsal, encoding, and retrieval processes, and therefore, better facilitate learning. Gagné (1985) identified nine processes of information processing and related external instructional events to each process. Using his model of information processing as a framework, Wager and Mory (1993) analyzed the different roles that questions and feedback may serve in learning at each stage of information processing. Questions and feedback provided in this study mainly were expected to serve the functions identified in three stages of information processing in their analysis. Table 1 provides a summary of the expected roles of direct manipulation matching questions and animation-elaborated feedback during those three stages of information processing.

Table 1
Expected Roles of Direct Manipulation Matching Questions and Animation-Elaborated Feedback in the Three Stages of Information Processing

Stages of Information Processing	**Expected Roles of Direct Manipulation Matching Questions**	**Expected Roles of Animation-Elaborated Feedback**
Rehearsal to maintain information in STM	• Provides practice on previous learned information • Helps learners organize, group, and chunk information into meaningful units	• Provides dynamic visual reinforcement to the learner's response
Semantic encoding for storage in LTM	• Facilitates and strengthens rapid encoding • Helps learners integrate new knowledge into existing cognitive structure	• Validates integration • Elaborates facts, concepts, and rules/principles
Retrieval from LTM to STM	• Facilitates retrieval • Activates response organization • Tests for understanding or misunderstanding	• Provides dynamic visual reinforcement to the learner's response

Levels of processing theory (Craik & lockhark, 1972) claims people process incoming information at a successive series or hierarchy of processing levels (stages) simultaneously based on its characteristics. Direct manipulation matching questions and animation-elaborated feedback were supposed to better facilitate deeper processing of the information from shallow to deep, and from sensory stage, to matching and pattern recognition stage, and then to semantic-associative stage. Dual coding theory identified three distinctive levels of processing within and between the verbal and visual systems: (1) representational, (2) associative, and (3) referential (Paivio, 1986). Direct manipulation matching questions and animation-elaborated feedback were believed to better facilitate these three levels of processing and therefore, facilitate learning. Generative learning theory (Wittrock, 1974a, 1974b) is concerned with how learners process information and actively construct meaning from it. Direct manipulation matching questions and animation-elaborated feedback should be more likely to help build two types of relationships identified in generative learning theory: organizational and reorganizational relationships between and among different parts of the external information, and integrated relationships between the external information and the learner's prior knowledge. Therefore, they should be more likely to facilitate learning.

Figure 1 provides a graphical representation of the theoretical framework for this study.

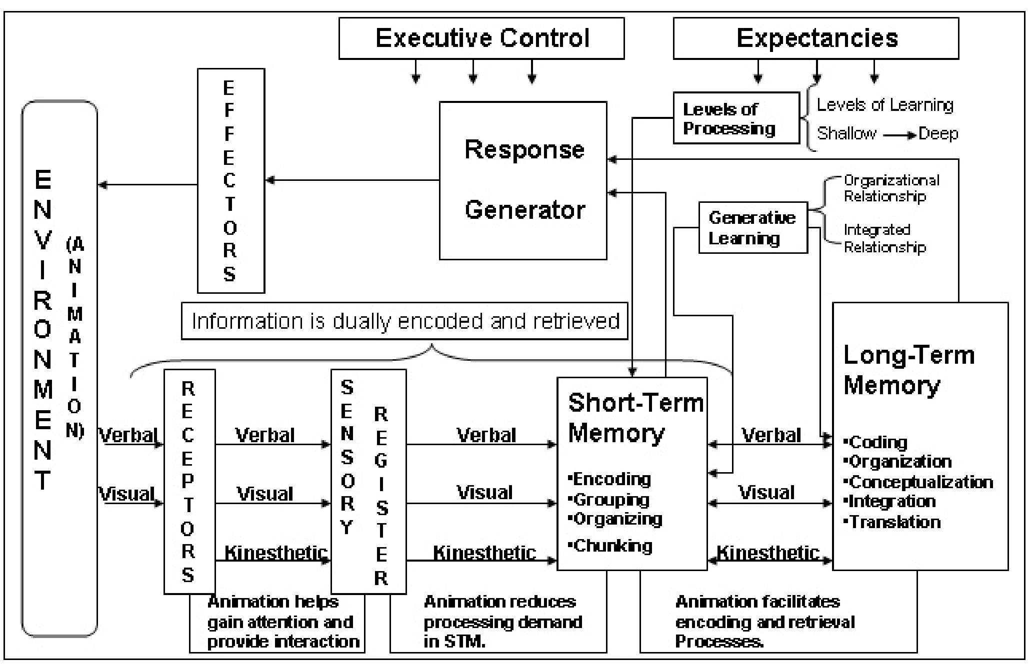

Figure 1. Theoretical framework. Source: from Gagné, R. M. and Driscoll, M. P., *Essentials of learning for instruction*, 2/e. Published by Allyn and Bacon, Boston, MA. Copyright © 1988 by Pearson Education. Adapted by permission of the publisher.

Direct Manipulation Strategy

Hutchins et al. (1985) suggested direct manipulation interfaces make learners feel directly engaged with the controlled objects, not with the programs or computers. Haag (1995) explained that "direct manipulation provides the learner with control over the movement and placement of graphical elements using the mouse …. This type of capability of the computer allows for interaction with visuals in an innovative manner" (p. 25). Grabowski (2003) suggested that manipulation of objects can be considered as a generative activity because it creates and extends a relationship between the parts of the environment. Despite the advantages of direct manipulation strategy, little research has been conducted to investigate its instructional effectiveness on learning.

Haag and Grabowski (1994) investigated the effects of manipulation strategy and found learners in the visual summary with manipulation group performed better than those in learner manipulation or those in the computer manipulation groups in the problem solving test. Haag (1995) conducted an experimental study and examined the effects of generative and non-generative visual manipulation strategies in CBI. Four treatment groups included: visual summary with manipulation, learner manipulation, computer manipulation, and a control group. She found no main effects for manipulation strategies. The control groups, however, showed highest mean scores. The above studies show that there are still questions about the effectiveness of direct manipulation. Furthermore, none of them examined the instructional effects of direct manipulation questioning strategy compared to the traditional questioning strategies, such as traditional matching questions. In addition, Haag's direct manipulation strategy required the learners to manipulate visual screen elements, while this study required the learners to manipulate verbal screen elements.

Animation-Elaborated Feedback Strategy

Rieber (1990) claimed that animation is a powerful way to create a wide variety of practice strategies which has broadened the nature of the interaction between the student and an instructional task significantly. He pointed out that when used in the most structured practice activities, animations were used as feedback to student answers providing reinforcement to correct answers. On the other hand, animation can be used in highly interactive programs in which animated graphics change continuously over time based on student input.

A series of research studies (Rieber, 1996; Rieber, Tzeng, Tribble & Chu, 1996) examined the specific role of real-time graphic feedback and how learners select, process, and interpret real-time feedback provided by animation. However, these studies have been focused on using animation as continuous visual feedback in a simulation environment. More research needs to be conducted to investigate the instructional effects of animation used as a feedback to learners' responses providing reinforcement in more structured practice activities. In this study, animation-elaborated feedback provided immediate informational feedback by demonstrating or elaborating a lesson fact, concept, rule or principle when the learner's response was correct.

Prior Knowledge

Prior knowledge has been considered the most important single factor influencing learning (Ausubel, 1968). Jonassen and Grabowski (1993) defined prior knowledge and achievement as the knowledge, skills, or abilities brought by learners to the learning environment before instruction. According to Dwyer (1994), because prior knowledge of lower-level objectives predicts performance in higher-order objectives, it should be included in any study of higher-order learning. Although students were randomly assigned to different treatments, their prior knowledge was still tested to wash out any effects it might have on learning.

Research Purpose and Questions

This research study focused on the instructional effects of two specific instructional strategies: questioning strategies and feedback strategies. This purpose was to investigate the instructional effects of two types of questioning strategies (traditional matching questions, and direct manipulation matching questions) and two types of feedback strategies (knowledge of response (KOR) text feedback only, and KOR text plus animation-elaborated feedback). The traditional matching questions, direct manipulation matching questions and the animation-elaborated feedback were designed based on cognitive processing requirements of three levels of learning: factual, conceptual, and rules and principles.

Three research questions were explored. (1) Were no questions, traditional matching questions, and direct manipulation matching questions equally effective in facilitating student achievement on tests measuring different educational objectives? (2) Were no feedback, KOR text feedback only, and KOR text plus animation-elaborated feedback equally effective in facilitating student achievement on tests measuring different educational objectives? (3) Was there an interaction between the question type and the feedback type?

Methods

Participants

Participants were 184 undergraduate volunteers enrolled in a non-major biology entry level course during the fall 2005 semester in a large land grant university in northeastern USA. Students in this class included freshmen through seniors from all kinds of majors across campus.

Instructional Materials

The self-paced web-based instruction used in this study was adapted from a color-coded, paper-based booklet developed by Dwyer and Lamberski (1977) about the human heart. The content contained approximately 1,800 words and was divided into three sections: the parts of the heart, circulation of blood, and cycle of blood pressure. The paper-based instructional booklet was developed into a 21-screen web-based instruction. Ten additional practice screens were designed and developed for treatments 2, 3, 4 and 5 in order to integrate questioning and feedback strategies into the instructional material: four practice screens were placed after the first content section (the Parts of the Heart), three were placed after the second content section (Circulation of Blood), and three were placed after the third content section (Cycle of Blood Pressure).

Item Analysis

Integration and positioning of the questioning and feedback strategies were determined by an item analysis that identified where students were having difficulties based on their performance on the criterion tests from a pilot study conducted with 35 students enrolled in the same Biological Science course. From the item analysis, 37 of a total of 60 test items were identified in the three criterion tests in which student achievement was less than or equal to 60% correct (5 items in the Identification test, 14 items in the Terminology test, and 18 items in the Comprehension test). The content referred to in the 37 test items was located on 15 instructional computer screens.

Treatments

Five instructional treatments were included in the present study. Treatment 1 contained 1 directions screen and 20 instructional screens. No questions or feedback practices were presented. Treatments 2, 3, 4, and 5 contained additional 10 practice screens which included questioning and feedback strategies to help students practice on the content referred to by the difficult test items identified through the item analysis. In each treatment, the web-based instruction was self-paced.

Treatment 1: No questions and no feedback (Control group). This web-based treatment contained 21 screens (1 directions screen and 20 instructional screens) with instructional text on the left side and the corresponding static graphic on the right side of each screen. No questions and feedback practices were provided. See example screenshot in Figure 2.

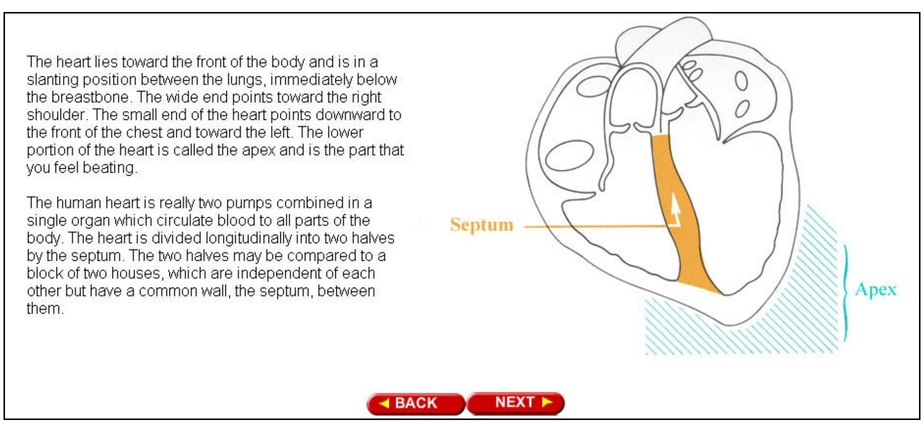

Figure 2. Example instructional screen received by the control group (T1).

Treatment 2: Traditional matching questions with KOR text feedback. Three types of traditional matching questions with KOR text feedback were embedded in the 10 additional practice screens to facilitate factual, conceptual, and rules and principles learning. See example screenshot in Figure 3. For facts, students were required to correctly identify and match the concept names with their corresponding graphical parts by clicking on the correct

radio button under each concept name. For concepts, students were required to correctly identify and match the concept attributes with their corresponding concept names by clicking on the correct radio button under each concept attribute. For rules and principles, students were required to correctly identify and match the "If…" statements with their corresponding "then…" statements by clicking on the correct radio button under each "If…" statement. Text feedback was provided in red as either "Correct" or "Wrong" at the top of the screen once the student clicked on a radio button. After the students correctly responded to all matching questions, the "NEXT" button was activated so that they could proceed to the next screen. It was expected that this type of practice strategy would facilitate factual, conceptual, and rules and principles learning through covert mental matching and KOR text feedback.

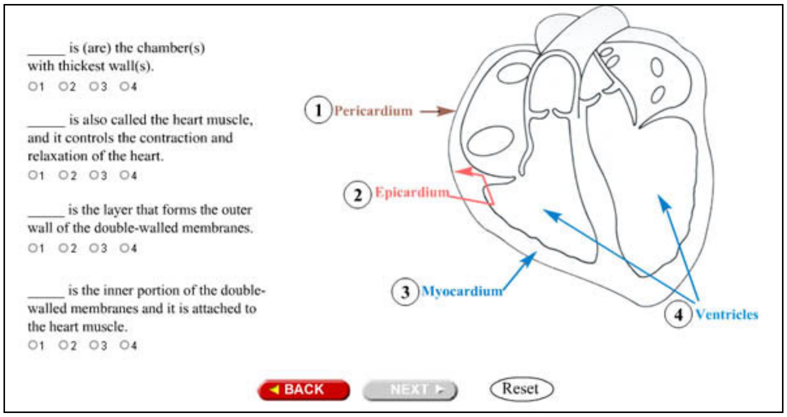

Figure 3. Example practice screen for concepts received by T2.

Treatment 3: Traditional matching questions with KOR text plus animation-elaborated feedback. This treatment was the same as treatment 2 except that when the students clicked on the correct radio button, one of the three types of animation-elaborated feedback was also displayed simultaneously in addition to the text feedback displayed in red as "Correct." See example screenshots in Figure 4. For facts, animation highlighted the corresponding graphical parts of the concepts. For concepts, animation demonstrated the attributes of the corresponding concepts using dynamic visuals. For rules and principle, animation illustrated the cause-and-effect or correlational relationships between the "If…" and "then…" statements. When the wrong radio button was clicked, text feedback was displayed in red as "Wrong," but no animation was played. It was expected that this type of practice strategy would facilitate factual, conceptual, and rules and principles learning through covert mental matching and KOR text plus animation-elaborated feedback.

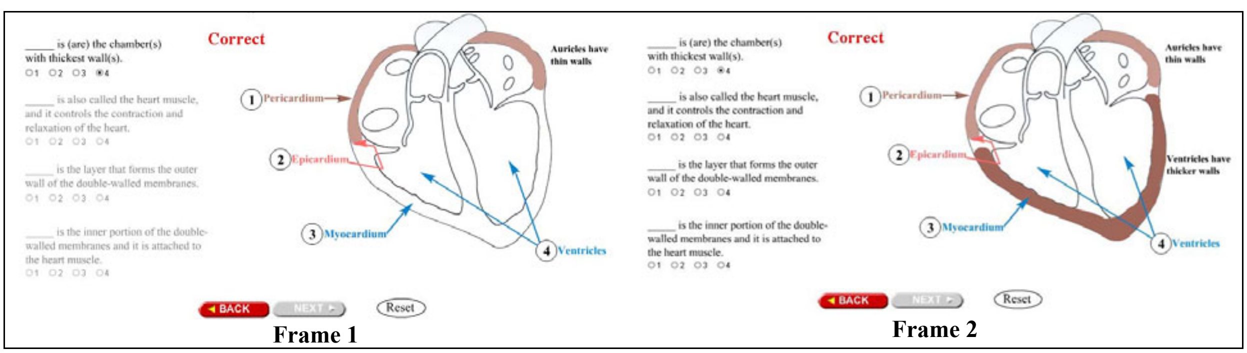

Figure 4. KOR text plus animation-elaborated feedback for concepts received by T3.

Treatment 4: Direct manipulation matching questions with KOR text feedback. Three types of direct manipulation matching questions with KOR text feedback were embedded in the 10 additional practice screens to facilitate factual, conceptual, and rules and principles learning. See example screenshot in Figure 5. For facts, students were required to correctly identify, and click and drag the concept names and drop them into the placeholders pointing to their corresponding graphical parts. For concepts, students were required to correctly identify, and click and drag the concept attributes and drop them into the placeholders under their corresponding

concept names. For rules and principles, students were required to correctly identify, and click and drag the "If…" statements and drop them into the placeholders above their corresponding "then…"statements. Text feedback was provided in red as "Correct" at the top of the screen when the student dropped either the concept name, concept attribute, or "If…" statement into the correct placeholder. When the item was dropped anywhere else other than the correct placeholder, text feedback was displayed in red as "Wrong," and the item would pop back to its original position providing negative animation feedback. Then the students could drag and drop it again. After the students correctly responded to all matching questions, the "NEXT" button was activated so that they could proceed to the next screen. It was expected that this type of practice strategy would facilitate factual, conceptual, and rules and principles learning through covert mental matching, overt direct manipulation, and KOR text feedback.

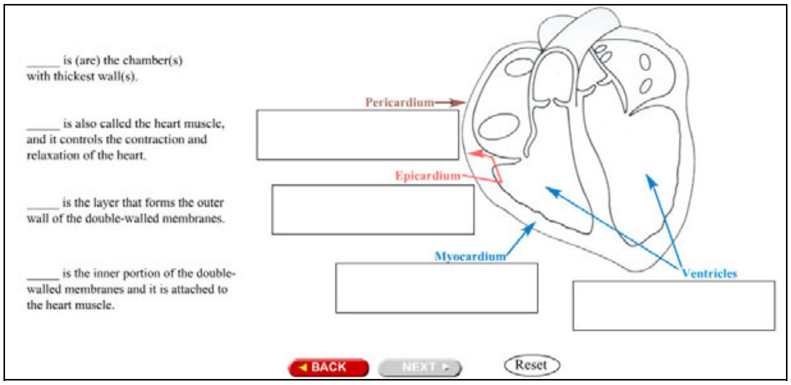

Figure 5. Example practice screen for concepts received by T4.

Treatment 5: Direct manipulation questioning strategy with KOR text plus animation-elaborated feedback. This treatment was the same as treatment 4 except that when the students dropped either the concept name, concept attribute, or "If…" statement into the correct placeholder, one of the three types of animation-elaborated feedback was also displayed simultaneously in addition to the text feedback displayed in red as "Correct." The three types of animation-elaborated feedback were the same as those described in treatment 3. It was expected that this type of practice strategy would facilitate factual, conceptual, and rules and principles learning through covert mental matching, overt direct manipulation, and KOR text plus animation-elaborated feedback.

Procedures

The three-stage study included an online pretest to determine the participants' prior knowledge, followed by the web-based treatments and three online criterion tests (Identification, Terminology, and Comprehension). All stages were completed in computer labs. The result of the human physiology pretest of the participants was used as a covariate to help analyze and interpret the results.

Measurement Instruments

The pretest and three criterion tests were developed by Dwyer (1978). The pretest consisted of 36 multiple-choice questions on human physiology. The Cronbach's alpha reliability of the pretest was .45 (n = 184). Each of the three criterion tests consists of 20 multiple-choice questions to measure different learning objectives. The Identification test measured student ability to identify the names and positions of the parts. The Terminology test measured student knowledge of specific facts, terminologies, and definitions. The Comprehension test measured student understanding of complex procedures and/or processes. There was no time limit for test completion. Each test item was worth 1 point for a total of 20 possible points per test. The Cronbach's alpha reliabilities for the three criterion tests were all above 0.8 when data were analyzed with all test items. Further analysis with the subset of difficult items in each criterion test showed that the Cronbach's alpha reliabilities were all above 0.6.

Data analysis

The study used an incomplete 3 x 3 factorial design with five treatment groups. The two factors included the type of questioning strategies and the type of feedback strategies. Two-way MANCOVAs were conducted with all test items as well as subset of difficult test items in each criterion test to test for the main effects and the interaction between the two factors. A significance level of .05 was set for all statistical tests.

Results

Descriptive Statistics

Table 1 presents the means and standard deviations for the three criterion tests examined by question type and feedback type.

Table 1
Means and Standard Deviations for the Three Criterion Tests by Question Type and Feedback Type (All Items)

Test	Question Type	Feedback Type	Mean	S. D.	n
Identification	All question types	No feedback (T1)	13.03	4.53	37
		KOR text feedback (T2+T4)	14.22	4.61	73
		KOR text plus animation-elaborated feedback (T3+T5)	13.22	4.89	74
		All feedback types (T1+T2+T3+T4+T5)	13.58	4.72	184
	No question	No feedback (T1)	13.03	4.53	37
		Total	13.03	4.53	37
	Traditional matching questions	KOR text feedback (T2)	14.69	5.05	36
		KOR text plus animation-elaborated feedback (T3)	13.61	4.47	36
		Total	14.15	4.77	72
	Direct manipulation matching questions	KOR text feedback (T4)	13.76	4.16	37
		KOR text plus animation-elaborated feedback (T5)	12.84	5.29	38
		Total	13.29	4.76	75
Terminology	All question types	No feedback (T1)	10.22	4.32	37
		KOR text feedback (T2+T4)	11.59	4.54	73
		KOR text plus animation-elaborated feedback (T3+T5)	10.82	4.68	74
		All feedback types (T1+T2+T3+T4+T5)	11.01	4.56	184
	No question	No feedback (T1)	10.22	4.32	37
		Total	10.22	4.32	37
	Traditional matching questions	KOR text feedback (T2)	12.56	4.80	36
		KOR text plus animation-elaborated feedback (T3)	11.17	4.72	36
		Total	11.86	4.78	72
	Direct manipulation matching questions	KOR text feedback (T4)	10.65	4.13	37
		KOR text plus animation-elaborated feedback (T5)	10.50	4.68	38
		Total	10.57	4.38	75
Comprehension	All question types	No feedback (T1)	10.14	4.17	37
		KOR text feedback (T2+T4)	10.52	4.53	73
		KOR text plus animation-elaborated feedback (T3+T5)	9.86	4.53	74
		All feedback types (T1+T2+T3+T4+T5)	10.18	4.45	184
	No question	No feedback (T1)	10.14	4.17	37
		Total	10.14	4.17	37
	Traditional matching questions	KOR text feedback (T2)	11.89	4.49	36
		KOR text plus animation-elaborated feedback (T3)	10.39	4.33	36
		Total	11.14	4.45	72
	Direct manipulation matching questions	KOR text feedback (T4)	9.19	4.21	37
		KOR text plus animation-elaborated feedback (T5)	9.37	4.72	38
		Total	9.28	4.44	75

Note. Each of the criterion test scores could range from a low of 0 to a high of 20.

Descriptively, Table 1 shows that regardless of question type, students who received KOR text feedback (T2+T4) had higher mean scores than students who received no feedback (T1) or KOR text plus animation-elaborated feedback (T3+T5) on all three criterion tests. The mean scores of students who received KOR text plus animation-elaborated feedback (T3+T5) were higher than students who received no feedback (T1) on the Identification test and Terminology tests, but were lower on the Comprehension test. Regardless of feedback type, students who received traditional matching questions (T2+T3) had higher mean scores than students who received no questions (T1) or direct manipulation matching questions (T4+T5) on all three criterion tests. The mean scores of students who received direct manipulation matching questions (T4+T5) were higher than students who received no questions (T1) on the Identification and Terminology tests, but were lower on the Comprehension test. Further analysis with the subset of difficult items in each criterion test showed the same trends (see Table 2).

Table 2

Means and Standard Deviations for the Three Criterion Tests by Question Type and Feedback Type (Subset of Difficult Items)

Test	Question Type	Feedback Type	Mean	S. D.	n
Identification (5 Items)	All question types	No feedback (T1)	2.59	1.50	37
		KOR text feedback (T2+T4)	3.25	1.49	73
		KOR text plus animation-elaborated feedback (T3+T5)	2.86	1.58	74
		All feedback types (T1+T2+T3+T4+T5)	2.96	1.54	184
	No question	No feedback (T1)	2.59	1.50	37
		Total	2.59	1.50	37
	Traditional matching questions	KOR text feedback (T2)	3.36	1.66	36
		KOR text plus animation-elaborated feedback (T3)	2.83	1.58	36
		Total	3.10	1.63	72
	Direct manipulation matching questions	KOR text feedback (T4)	3.14	1.32	37
		KOR text plus animation-elaborated feedback (T5)	2.89	1.61	38
		Total	3.01	1.47	75
Terminology (14 Items)	All question types	No feedback (T1)	6.35	3.15	37
		KOR text feedback (T2+T4)	7.60	3.25	73
		KOR text plus animation-elaborated feedback (T3+T5)	7.07	3.47	74
		All feedback types (T1+T2+T3+T4+T5)	7.14	3.33	184
	No question	No feedback (T1)	6.35	3.15	37
		Total	6.35	3.15	37
	Traditional matching questions	KOR text feedback (T2)	8.36	3.45	36
		KOR text plus animation-elaborated feedback (T3)	7.56	3.34	36
		Total	7.96	3.40	72
	Direct manipulation matching questions	KOR text feedback (T4)	6.86	2.90	37
		KOR text plus animation-elaborated feedback (T5)	6.61	3.57	38
		Total	6.73	3.24	75
Comprehension (18 Items)	All question types	No feedback (T1)	8.73	3.64	37
		KOR text feedback (T2+T4)	9.23	4.09	73
		KOR text plus animation-elaborated feedback (T3+T5)	8.61	4.10	74
		All feedback types (T1+T2+T3+T4+T5)	8.88	4.00	184
	No question	No feedback (T1)	8.73	3.64	37
		Total	8.73	3.64	37
	Traditional matching questions	KOR text feedback (T2)	10.44	4.01	36
		KOR text plus animation-elaborated feedback (T3)	9.08	3.93	36
		Total	9.76	4.00	72
	Direct manipulation matching questions	KOR text feedback (T4)	8.05	3.86	37
		KOR text plus animation-elaborated feedback (T5)	8.16	4.27	38
		Total	8.11	4.04	75

Note. The theoretical score for each criterion test was: Identification: 0 through 5; Terminology: 0 through 14; Comprehension: 0 through 18.

Analysis of Null Hypotheses

Data were analyzed with all test items as well as the subset of difficult items in each criterion test. Table 3 and table 4 showed the overall MANCOVA results using Pallai's Trace F.

Table 3

Two-Way Factorial MANCOVA Overall Test Results (n=184, All Items)

Source	Pillai's Trace	F	Sig	Partial Eta Squared	Observed Power
Covariate Prior Knowledge	.18	12.57	.000	.18	1.00
Question Level	.04	2.17	.094	.04	.54
Feedback Level	.01	.66	.579	.01	.19
Question Level by Feedback Level	.01	.57	.635	.01	.17

Note. Each of the criterion tests contains 20 items.

Table 4
Two-Way Factorial MANCOVA Overall Test Results (n=184, Subset of Difficult Items)

Source	Pillais Trace	F	Sig	Partial Eta Squared	Observed Power
Covariate Prior Knowledge	.17	11.72	.000	.17	1.00
Question Level	.05	3.00	.032	.05	.70
Feedback Level	.01	.85	.468	.01	.23
Question Level by Feedback Level	.01	.46	.709	.01	.14

Note. The Identification test contains 5 items, the Terminology test contains 14 items, and the Comprehension test contains 18 items.

The results of Pillai's Trace showed three finding. There were no significant differences in achievement among students who received either no questions, traditional matching questions, or direct manipulation matching questions when data were analyzed using all test items in each criterion test, $F(3,176) = 2.17$, $p = .094$ (see Table 3). However, further analysis with only the subset of difficult items in each criterion test found significant differences in achievement among students who received either no questions, traditional matching questions, or direct manipulation matching questions, $F(3,176) = 3.00$, $p = .032$ (see Table 4). Follow-up univariate pairwise comparisons revealed that students who received traditional matching questions (T2+T3, Mean = 7.96) performed significantly better than students who received no questions (T1, Mean = 6.35) on the Terminology test only, $p = .020$.

There were no significant differences in achievement among students who received either no feedback, KOR text feedback only, or KOR text plus animation-elaborated feedback, $F(3,176) = .66$, $p = .579$ (see Table 3). Further analysis with only the subset of difficult items in each criterion test also found no significant differences, $F(3,176) = .85$, $p = .468$ (see Table 4).

There was no significant interaction between the question type and the feedback type, $F(3,176) = .57$, $p = .635$ (see Table 3). Further analysis with only the subset of difficult items in each criterion test also found no significant interaction between the two factors, $F(3,176) = .46$, $p = .709$ (see Table 4).

Discussion

Effects of Different Types of Questioning Strategies

The results showed that traditional matching questions (T2+T3) and direct manipulation matching questions (T4+T5) were equally effective in facilitating student achievement in all criterion tests when data were analyzed with all test items as well as the subset of difficult items. The main reason might be because both traditional matching questions and direct manipulation matching questions may have matched the cognitive processing requirements. They were functionally the same, but structurally different.

Furthermore, the results showed that students who received traditional matching questions (T2+T3) showed higher mean scores than those who received direct manipulation matching questions (T4+T5) on all three criterion tests when data were analyzed with all test items as well as the subset of difficult items. Although the differences were not statistically significant at the .05 alpha level, according to Huck (2004), the difference between the two questioning strategies was approaching marginal significance on the Comprehension test. The trends may be explained by the following reasons. First of all, compared to the traditional matching questions, direct manipulation matching questions is a "… novel, unconventional, demanding and possibly a distracting generative strategy for students" (Haag, 1995, p. 86). Secondly, the manipulation or generative reorganization of information might have made the recall of specific facts and concepts more difficult for some learners. This argument was corroborated by the results reported by Perrig (1988) and Haag (1995). Thirdly, students with higher prior knowledge or familiarity with the content will benefit more from a conventional instructional strategy (Haag, 1995).

Additional results indicated that students who received no questions (T1) performed equally well as those who received traditional matching questions (T2+T3) and those who received direct manipulation matching questions (T4+T5) on all three criterion tests when data were analyzed with all test items and on the Identification and Comprehension tests when data were analyzed with the subset of difficult items. This may be explained by the following reasons. First of all, all 184 student volunteers in this study were from a Biological Science course who might have been very interested in the heart content, and therefore, might have been highly motivated to learn. Secondly, the instructional material itself might be powerful enough that the students did not need additional instructional practice strategies to facilitate their learning. However, the results also indicated students who received

traditional matching questions (T2+T3) performed significantly better than those who received no questions (T1) on the Terminology test when data were analyzed with the subset of difficult items. This suggested that students did benefit from traditional matching questions on learning difficult concepts.

Effects of Different Types of Feedback Strategies

The results indicated that no feedback, KOR text feedback only, and KOR text plus animation-elaborated feedback were equally effective in facilitating student achievement on the three criterion tests, The results concurred with those reported by Rieber and his colleagues (Rieber, 1996; Rieber et al., 1996) that graphical feedback, textual feedback, and graphical plus textual feedback were equally effective for students to learn explicit knowledge. However, the results were contradictory to what was expected based on the literature. This may be explained by the following reasons. First of all, compared to KOR text feedback, students were not familiar with the animation-elaborated feedback strategy and might not know how to attend to the relevant cues or details provided by animation. The support of this reasoning can be found in previous literature (i.e., Dwyer, 1978; Rieber, 1990, 2000). Secondly, animation-elaborated feedback might distract students' attentions from building generative relationships instead of facilitating their cognitive processing. Thirdly, the characteristics of the participants and the powerful instructional material itself could also help explain the equal effects of the different feedback strategies.

Conclusions

The following conclusions have been drawn: (1) traditional matching questions and direct manipulation matching questions were equally effective in facilitating factual, conceptual and rules and principles learning; (2) no questions, traditional matching questions, and direct manipulation matching questions were equally effective in facilitating factual, and rules and principles learning; (3) compared to no questions, traditional matching questions were more effective in facilitating learning difficult concepts; (4) no feedback, KOR text feedback, and KOR text plus animation-elaborated feedback were equally effective in facilitating factual, conceptual, and rules and principles learning; (5) instructional text with corresponding static graphics is still a very powerful instructional strategy; (6) learners need to be guided or trained in order to possibly benefit from direct manipulation matching questions; and (7) additional instructional strategies are needed in order to direct learner's attention to the most important information provided by animation (Rieber, 1990, 2000).

Implications for Instructional Designers

The following suggestions are provided for instructional designers: (1) for factual, conceptual, and rules and principles learning, results are no different whether traditional matching questions or direct manipulation matching questions are used. (2) for factual and rules and principles learning, using either no questions, traditional matching questions, or direct manipulation questions are equally effective on student learning; (3) for conceptual learning, using traditional matching questions should better facilitate learning difficult concepts versus no questions; (4) for factual, conceptual, and rules and principles learning, using no feedback, KOR text feedback only, and KOR text plus animation-elaborated feedback should be equally effective on student learning; (5) because instructional text with corresponding static graphics is still a very powerful instructional strategy, it may not be necessary to use additional instructional strategies to facilitate learning, especially when the learners have higher prior knowledge and are familiar with the content; (6) when direct manipulation matching questions are used, additional instructional strategies may be needed to guide learners; and (7) the same for using animations. Animations alone are not powerful enough to effect a difference in learning.

Recommendations for Future Research

The following recommendations are provided for future research: (1) rerun the study by providing detailed directions and practice for direct manipulation matching questions; (2) rerun the study by providing additional instructional strategies to cue learners to the most important information provided by animation-elaborated feedback; (3) rerun the study with a better designed animation-elaborated feedback; (4) rerun the study with students from a non-Biology course; and (6) investigate the effects of direct manipulation questions and animation-elaborated feedback on learning retention, learning efficiency, student motivation, interests and attitudes, and higher level learning tasks, such as problem-solving.

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