DOCUMENT RESUME

ED 454 838 IR 020 817

TITLE ICCE/ICCAI 2000 Full & Short Papers (Teaching and Learning Processes).

PUB DATE 2000-11-00

NOTE 241p.; In: Learning Societies in the New Millennium: Creativity, Caring & Commitments. International Conference on Computers in Education/International Conference on Computer-Assisted Instruction (Taipei, Taiwan, November 21-24, 2000); see IR 020 792. Some figures contain very small and illegible type.

PUB TYPE Collected Works - General (020) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC10 Plus Postage.

DESCRIPTORS *Computer Uses in Education; *Educational Technology; Elementary Secondary Education; Foreign Countries; Higher Education; *Learning Processes; *Teaching Methods; World Wide Web

IDENTIFIERS *Learning Environments; *Web Based Instruction

ABSTRACT

This document contains the full and short papers on teaching and learning processes from ICCE/ICCAI 2000 (International Conference on Computers in Education/International Conference on Computer-Assisted Instruction) covering the following topics: a code restructuring tool to help scaffold novice programmers; efficient study of Kanji using mnemonics and software; a networked constructive CAI (Computer-Assisted-Instruction) system using a multiplication concept; the relation between touch-typing skill and thinking-typing; an assessment framework for information technology integrated instruction; cognitive effects of collaborative learning processes on students' computer programming; application of the Gray relationship matrix and learning obstacles analysis to discovery teaching; staff development for teaching and learning online; comparing computer anxiety by gender among technological college students; a cross-national comparison of computer anxiety and locus of control between preservice teachers in Taiwan and the United States; computer-mediated language learning; the gap between the discourse and the application of socio-constructivist principles of preservice teachers using information and communication technologies; a log-file analysis program for assessing navigation processes; evaluating educational multimedia; evaluation of class organization in computer literacy education; evaluation of the World Wide Web-based learning system; developing successful collaborative projects between European initial teacher education students; evaluating children interacting, collaborating, and learning with computers; facilitating examples understanding through explicit questioning; information technology in instrumental music teaching and learning; learning from the learning of other students; making the most of the Internet's potential for education; networked constructive CAI system putting emphasis on communication and discussion; online ESL (English as a Second Language) learning; the introductory and motivational stage of activity in a computer tutoring system; female Asian faculty's perspectives on educational technology; strategies for searching on the Web; factors to consider prior to designing computer-assisted learning for higher education; students' attitude toward WPSS (Web-based Performance Support Systems) in supporting classroom learning; students' thinking processes when learning with computer-assisted

mass lectures; telementoring in surgery; the "half-life" of knowledge in the university of the 21st century; social discourse in a network-based learning community; the artistic interface; the dynamic knowledge generation and the learning potential ability; the distance ecological model to support self/collaborative learning in the Internet environment; students' reactions to the process of learning programming; the difficulty of asynchronous learning materials based on time distribution; using information technology in education for preservice teacher education; using virtual environments for studying water phases and phase transitions; and a Web-based subject-oriented learning program on geophysics for senior high school. (MES)

ICCE/ICCAI 2000 Full & Short Papers (Teaching and Learning Processes)

Proceedings

Content

Full & Short Papers (Teaching and Learning Processes)

▲ HOME

A Code Restructuring Tool to help Scaffold Novice Programmers

Stuart Garner
Edith Cowan University
Pearson St., Churchlands 6018, Western Australia
E-mail: s.garner@ecu.edu.au

This paper concerns a new software tool called CORT (code restructuring tool) that has been developed by the author to help students learn programming. The paper begins by discussing the difficulties that students face when learning to program and the use of part complete solutions as a teaching and learning method that reduces the cognitive load that students experience.

CORT has been developed to support this use of part complete solutions and its features are outlined. When used by a student, a part complete solution to a given programming problem is displayed in one window and possible lines of code that can be used to complete the solution are displayed within another window. The lines can easily be moved between the windows in order to complete the solution and the solution then transferred to the target programming environment for testing purposes.

Finally, the use of CORT with both undergraduate and postgraduate students at Edith Cowan University is described, preliminary feedback from students indicating that CORT is easy to use and that they perceive that it is helping them in their learning of programming. Four different methods of using CORT have been identified and these will be the subject of future research.

Keywords: **Scaffolding, Programming, Flexible Learning.**

1 Introduction

Learning to write computer programs is not easy [3, 18] and this is reflected in the low levels of achievement experienced by many students in first programming courses. For example, Perkins, Schwartz et al [17] state that:

> *Students with a semester or more of instruction often display remarkable naivete about the language that they have been studying and often prove unable to manage dismayingly simple programming problems.*

and King, Feltham et al [8] state that:

> *even after two years of study, many students had only a rudimentary understanding of programming*

Over the years since the advent of high level programming languages in the 1960s, much has been written about the problems that students have in learning programming and many ideas and initiatives have been put forward for improvements in the teaching and learning process with varying degrees of success. In practice, the ways in which teaching and learning takes place in the domain of programming have changed little and many students still find the learning of programming a very difficult process. The challenge of learning programming in introductory courses lies in simultaneously learning: general problem solving skills; algorithm design; program design; a programming language in which to implement algorithms as programs; and an environment to support the program design and implementation [6]. In addition, students need to learn testing and debugging techniques to validate programs and to identify and fix problems that they may have within their programs.

Additionally, we are moving ever more rapidly to use more student centred and flexible learning methods within the teaching and learning process. This means that our instructional design for programming courses needs to take notice of these moves and utilise these methods. Fortunately technological improvements have also been significant over the last few years enabling us to more easily produce engaging courseware that can help students studying in a flexible learning mode. As courseware designers, we can produce electronic scaffolds to help students in their learning processes when they are studying on their own with limited access to a human tutor.

2 Use of Worked Examples in the Teaching and Learning of Problem Solving and Programming

There are several methods used in the teaching and learning of programming and one of these is to utilise worked examples. Several researchers have experimented with the use of worked examples in place of conventional instruction and found strong advantages. In the domain of algebra, Sweller and Cooper [19] suggested that students would learn better by studying worked examples until they had "mastered" them rather than attempting to solve problems as soon as they had been presented with, or familiarised themselves, with new material. In their research, students studied worked examples and teachers answered any questions that the students had. Students then had to explain the goal of each problem together with the steps involved in the solution and then complete similar problems until they could be solved without errors. Sweller and Cooper found that this method was less time-consuming than the conventional practice-based model and that students made fewer errors in solving similar problems than students who were exposed to the conventional practice-based model of instruction. There was no significant difference between the "worked example" group and the "conventional" problem solving group when they attempted to solve novel problems and it was therefore concluded that learning was more efficient and yet no less effective when this worked example method was used.

Worked examples are heavily used within the "reading" method of learning programming. According to Van Merrienboer et al [22, 23] the reading approach emphasises the reading, comprehension, modification and amplification of non-trivial, well-designed working programs. However, they also suggest that presenting worked examples to students is not sufficient as the students may not "abstract" the programming plans from them, a plan being a stereotyped sequence of computer instructions as shown in figure 1.

"Mindful" abstraction of plans is required by the voluntary investment of effort and the question then arises as to how we can get students to study the worked examples properly. In practice, students tend to rush through the examples, even if they have been asked to trace them in a debugger, as they often believe that they are only making progress in their learning when they are attempting to solve problems.

Lieberman [10] suggests that students should annotate worked examples with information about what they do or what they illustrate. Another suggestion is to use incomplete, well-structured and understandable program examples that require students to generate the missing code or "complete" the examples. This latter approach forces students to study the incomplete examples as it would not be possible for their completion without a thorough understanding of the examples' workings. An important aspect is that the incomplete examples are carefully designed as they have to contain enough "clues" in the code to guide the students in their completion. It is suggested that this method facilitates both automation, students having blueprints available for mapping to new problem situations, and schemata acquisition as they are forced to mindfully abstract these from the incomplete programs [24].

In one study, two groups of 28 and 29 high-school students from grades 10 to 12 participated in a ten lesson programming course using a subset of COMAL-80 [24]. One group, the "generation" group, followed a conventional approach to the learning of programming that emphasised the design and coding of new programs. The other group, the "completion" group, followed an approach that emphasised the modification and extension of existing programs. It was found that the completion group was better than the generation group in constructing new programs. It was found that the percentage of correctly coded lines was greater and that looping structures were more often combined with correct variable initialisation before a loop together with the correct use of counters and accumulators within the loop. It would appear that the completion strategy had indeed resulted in superior schemata formation for those students within that group. In addition, the completion group used superior comments in connection with the scope and goals of the programs, indicating that they had developed better high-level templates or schemata. It was noted in the study however that both groups were equal in their ability to interpret programs and that this might indicate that students in the completion group do not understand their acquired templates. It is then suggested that future completion strategies should include the annotation of the examples by students with details of what they are supposed to do and details of the templates (plans) that are being used.

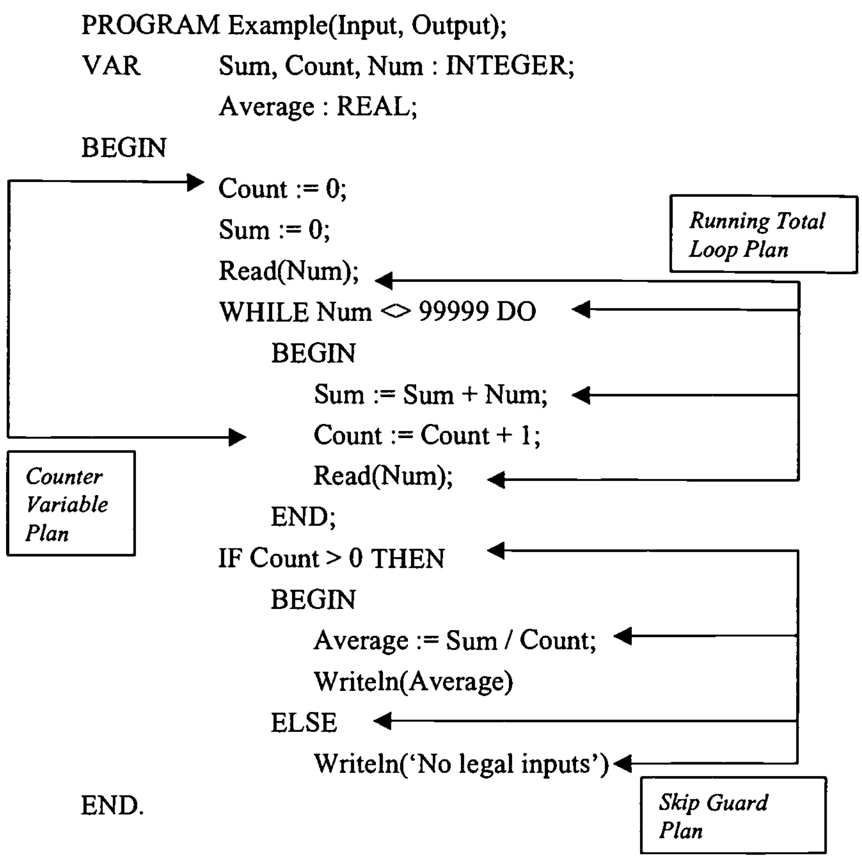


Figure 1

A side effect of the research was also noted. The drop-out rate from the completion group was found to be lower than for the generation group, particularly for female students with low prior knowledge. It was suggested that perhaps the generation of complete programs is perceived as a difficult and menacing task and that the completion strategy overcomes this difficulty.

The stimulation of the "mindful of abstraction" of schemata in students can possibly be improved further requiring them to also annotate the solutions with details of the scope and goals of the solutions and to answer questions on the inner workings of the solutions. The "degree" of completion of the solutions is an important aspect within the completion strategy and in some later work [23] examples are given of completion assignments that might be used early and later in a programming course. In an early part of a course, an example may indeed be complete and include explanations and a question on its inner workings. In the latter part of a course, the example may be largely incomplete and include a question on its workings and an instructional task. Between these two extremes, examples will have varying degree of completeness and in all cases, the incomplete examples are acting as scaffolds for the students.

3 The Cloze Procedure

A scaffolding tool called CORT (Code Restructuring Tool) has been produced that allows students to fill in lines of missing code from programs and this method is based upon the cloze procedure. The term is derived from "closure", a Gestalt psychology term referring to the human tendency to complete a familiar but not quite finished pattern [2]. The use of cloze was first used to measure comprehension in English readability [9] however it has also been used in the teaching and learning of programming as a way of measuring student understanding of programs [7, 20]. Such program comprehension tests are constructed by replacing some of the "words" or tokens by blanks and requiring students to fill in the blanks during a test. The use of the cloze procedure in testing was found to correlate well with conventional comprehension, question – answer, type quizzes and is also much easier to create and administer, see for example the work of Cook, Bregar et al [2].

Other researchers have experimented with the testing of program comprehension by omitting complete lines of code from programs and requiring students to fill in those lines [5, 13, 14, 15, 16]. Norcio found that students were more likely to supply correct statements if they had been omitted within a logic segment rather than from the beginning of a segment. This is consistent with the chunking hypothesis [12] that specifies that the first element of a chunk provides the key to the contents of the entire unit. Ehrlich looked at the differences between experts and novices in filling in missing lines within various programming plans and, as expected, found that the experts filled in the lines correctly taking into account the surrounding plan whereas novices had more difficulty.

In the various experiments in program comprehension using the cloze procedure, the students had to fill in the lines of code without being given a selection of lines to choose from. In some work done in an area unrelated to programming, students were expected to create an essay using a file of statements, only some of which were relevant to the topic [4]. The students were expected to copy and paste only the statements which they believed to be relevant and then to link them with their own text and it was suggested that learners would consolidate their understanding of the topics by having to actively evaluate all possible statements. The file of statements was acting as a scaffold to student learning.

Although the literature suggests that the cloze procedure has only been used in measuring program comprehension, it appears that it could prove useful as a way of scaffolding student learning of programming. An incomplete solution to a programming problem could be given to a student together with a choice of statements that might be used in the solution. The student would then have to study the incomplete solution and the choice of statements and decide which statements to use and where to put them. CORT uses this idea making the mechanics of placing the statements into the incomplete solution very straightforward for the student and eliminating typing errors and therefore also syntax errors.

4 The Code Restructuring Tool (CORT)

CORT has been designed to support the "completion" method of learning to program and it was decided that the following features would be required in the first prototype:

- Support for part-complete solutions to programming problems. Such solutions help in schemata creation and also reduce cognitive load.
- A mechanism so that missing statements can easily be inserted into a part-complete solution and also moved within that solution. This provides scaffolding for students.
- A facility so that students can add and amend lines of code. This would allow scaffolding to be reduced and for students to add more of their own code.
- For visual programming, a facility for students to easily view the target interface. The interface should be annotated with the various object names thereby reducing any split-attention effect and helping reduce cognitive load [1].
- A facility to access tutor created questions concerning the programming problems being attempted and for students to enter answers to those questions. This will promote reflection and higher order thinking.
- A facility to easily transfer a completed solution from CORT to the target programming environment.
- A facility to easily transfer programming code from the target programming environment back into CORT for further amendment.

4.1 The CORT Design

The user interface of CORT has been designed taking into consideration the three issues that have been suggested by Marcus [11] as being fundamental to interface design, namely development, usability, and acceptance. The interface for CORT is shown in figure 2.

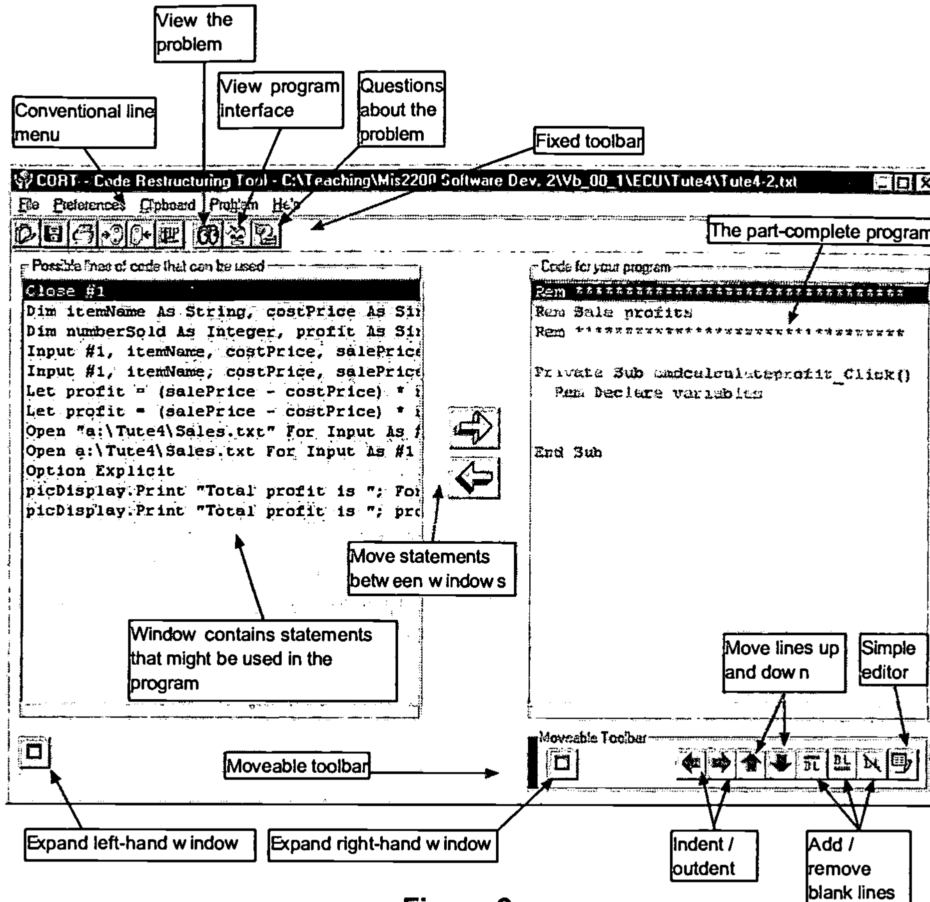


Figure 2

The ways in which the CORT design supports the list of required features are described in the following table.

Feature	Support in CORT Design
Support for part-complete solutions to programming problems	The part-complete solutions are automatically loaded into the right hand window and possible statements into the left hand window. Students load these from a file.
A mechanism so that missing statements can easily be inserted into a part-complete solution and also moved within that solution	Two buttons in the middle of the screen will move lines between the windows. One line, or several lines can be selected and moved across.
A facility so that students can add and amend lines of code	A simple editor is provided so that students can add their own lines or amend existing lines.
For visual programming, a facility for students to easily view the target interface	Access to this feature is via a button on the fixed toolbar.
A facility to access tutor created questions on the workings of the programming examples and to enter student answers	Access to this feature is via a button on the fixed toolbar. Student answers are automatically saved.
A facility to easily transfer a completed solution from CORT to the target programming environment	This is provided by a button on the main toolbar. A single click will copy the contents of the right hand window to the Windows clipboard ready for pasting into the Visual BASIC programming environment.

A facility to easily transfer programming code from the target programming environment back into CORT for further amendment	This is provided by a button on the main toolbar. A single click will paste the contents of the Windows clipboard into the right hand window, overwriting what is there.

4.2 Use of CORT by Students

A student would typically use CORT as follows:

1. A student loads in a CORT file and the two windows display a part-complete solution to a problem together with possible lines to be used. There is a facility available for the contents of the two windows to be printed out.
2. The student can view the problem statement and the Visual BASIC solution interface by clicking on the appropriate buttons on the fixed toolbar. The problem statement may have already been provided to the student in the form of a handout, however there is also a facility to print it from within CORT.
3. The student moves certain lines from the left hand window to the right hand window in an attempt to complete the solution. Lines can be moved up or down, and indented or outdented in the right hand window. Some problems have too many lines in the left hand window, some of those lines being incorrect.
4. If necessary, the student can invoke a simple editor to amend, add or delete lines of code.
5. The student clicks on the appropriate button to copy the contents of the right hand window to the Windows clipboard.
6. The student invokes Visual BASIC and loads the file that contains the interface for the solution. This is in effect the Visual BASIC solution to the problem without the lines of code and was created by the tutor.
7. The student pastes the contents of the Windows Clipboard into the Visual BASIC editor and tests the program to determine if it works correctly. Use is made of the trace and debugging facilities of Visual BASIC. These facilities provide an insight to the workings of the notional machine.
8. If the student finds a problem with the working of the program, they can return to CORT and make the changes to the code there.
9. The student repeats steps 3 to 8 until they have a working program.
10. The student answers the tutor's questions concerning the programming problem that they have just attempted.

4.3 Initial Student Feedback

CORT has been used for one semester with both undergraduate and postgraduate students in the Faculty of Business and Public Management. The particular units are in the area of software development and the language that the students learn is Visual BASIC.

Each week the students have to undertake completion programming exercises using CORT and after each problem they were asked to comment on the use of CORT for the particular problem that they had just finished. The data was collected on-line through the Web and below are some of the comments that were received:

1. It's very helpful. I can see the interface of the program before actually running it.
2. I think CORT is a very useful tool to play around the codes. It saves me time copying and pasting.
3. Considering the increased workload as the semester progresses it is a bit of a relief that the exercises are much easier with the "fill in the gap" type format in CORT.
4. Without CORT, it's sure that I'll have a lot trouble with this particular problem, which focuses on arrays (a difficult topic). Thanks CORT...
5. CORT was useful in that the part solution helped to understand the logic of VB code
6. CORT is useful . However, I have used the unit text to try to understand the indentation format when writing the code. The directional keys are great for editing the code to meet the required format.

7. This was a challenge! I think that CORT is useful so long as I am not tempted to simply manipulate code until the program runs. If I were having to write programs from scratch I would use CORT so as to format and manipulate code and modules or sub procedures etc.

5 Conclusions

As can be seen from the above, the initial feedback on the use of CORT has been favourable. We have found that students can undertake two or three small programming problems within a one hour tutorial whereas without CORT they could only undertake one such problem. Also, without using CORT students often never manage to successfully complete their assigned problems and this certainly affected their motivation.

By using CORT, students do not have to be concerned with the design of programming interfaces which considerably reduces the cognitive load in the initial stages of learning programming. Also, the reduction of "split attention affect" by labelling all the objects with their names has been very popular with the students.

The above has described a preliminary study of the use of CORT and it has been undertaken to determine its suitability and to fine tune some of its features. CORT can be used in several ways and four distinct methods have now been identified. These will be the subject of further research. The four methods are as follows:

1. **All** of the lines that are required to complete a program are made available in the left hand window of CORT. There are no extra lines displayed in the left hand window.
2. **All** of the lines that are required to complete a program are made available in the left hand window of CORT. There are also additional lines displayed in the left hand window that are not required within the program. The extra lines are similar to the required lines, however they are incorrect and act as "red herrings".
3. **Some** of the lines that are required to complete a program are made available in the left hand window of CORT. Other lines that are required for the program completion need to be keyed in by the student.
4. **None** of the lines that are required to complete a program are made available in the left hand window of CORT. All of the lines that are required for the program completion need to be keyed in by the student.

References

[1] Chandler, P. and Sweller, J. (1991). Cognitive load theory and the format of instruction. Cognition and Instruction 8: 293-332.

[2] Cook, C., Bregar, W., et al. (1984). A Preliminary Investigation of the use of the Cloze Procedure as a Measure of program Understanding. Information Processing & Management **20**(1-2): 199-208.

[3] du Boulay, B. (1986). Some Difficulties in Learning to Program. Journal of Educational Computing Research **2**(1): 57-73.

[4] Edward, N. (1997). Development of a cost effective computer assisted learning (CAL) package to facilitate conceptual understanding. CAL97, University of Exeter, UK.

[5] Ehrlich, K. and Soloway, E. (1984). An Empirical Investigation of the Tacit Plan Knowledge in Programming. Human Factors in Compter Systems. J. Thomas and M. L. Schneider. Norwood, New Jersey, Ablex: 113-133.

[6] Fowler, W. A. L. and Fowler, R. H. (1993). A Hypertext Approach to Computer Science Education Unifying programming Principles. Journal of Multimedia and Hypermedia **2**(4): 433-441.

[7] Hall, W. E., III and Zweben, S. H. (1986). The Cloze Procedure and Software Comprehensibility Measurement. IEEE Transactions on Software Engineering **May 1986**: 608-623.

[8] King, J., Feltham, J., et al. (1994). Novice Programming in High Schools: Teacher Perceptions and New Directions. Australian Educational Computing(Sep 1994,): 17-23.

[9] Klare, G. R. (1974-75). Assessing Readability. Reading research quarterly(10): 63-102.

[10] Lieberman, H. (1986). An Example Based Environment for beginning Programmers. Instructional Science **14**(3): 277-292.

[11] Marcus, A. (1992). Graphic Design for Electronic Documents and User Interfaces. New York, ACM Press.

[12] Miller, G. A. (1956). The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity to Process Information. Psychological Review(63): 81-97.

[13] Norcio, A. F. (1980a). Comprehension Aids for Computer Programs. American Psychological Association Annual Meeting, Montreal.

[14] Norcio, A. F. (1980b). Human Memory Processes for Comprehending Computer Programs. Cybernetics and Society, Cambridge, Massachusetts.

[15] Norcio, A. F. (1981). Chunking and Understanding Computer Programs. Human-Machine Systems Symposium, Boston, USA.

[16] Norcio, A. F. (1982). Indentation, Documentation and Programmer Comprehension. Human Factors in Computer Systems, Gaithersburg, Maryland.

[17] Perkins, D. N., Schwartz, S., et al. (1988). Instructional Strategies for the Problems of Novice Programmers. Teaching and Learning Computer Programming: Multiple Research Perspective. R. E. Mayer, Hillsdale, NJ: Erlbaum: 153-178.

[18] Scholtz, J. and Wiedenbeck, S. (1992). The role of planning in learning a new programming language. International journal of man-machine studies 37: 191-214.

[19] Sweller, J. and Cooper, G. A. (1985). The use of worked examples as a substitute for problem solving in learning algebra. Cognition and Instruction 2(1): 59-89.

[20] Thomas, M. and Zweben, S. (1986). The Effects of Program-Dependent and Program-Independent Deletions on Software Cloze Tests. Empirical Studies of Programmers: 138-152.

[21] van Merrienboer, J. J. G. (1990). Strategies for Programming Instruction in High School: Program Completion vs. Program Generation. Journal of educational computing research. 6(3): 265-.

[22] van Merrienboer, J. J. G. and Krammer, H. (1987). Instructional Strategies and tactics for the design of Introductory Computer programming Courses in High School. Instructional Science 16(3): 251-285.

[23] van Merrienboer, J. J. G., Krammer, H. P. M., et al. (1994). Automating the planning and construction of programming assignments for teaching introductory computer programming. Automating Instructional Design, Development, and Delivery (NATO ASI Series F, Vol. 119). R. D. Tennyson, Springer Verlag, Berlin.: 61-77.

[24] van Merrienboer, J. J. G. and Paas, F. (1990). Automation and Schema Acquisition in learning elementary computer programming. Computers in Human Behavior(6): 273-289.

A new method for efficient study of *Kanji* using mnemonics and software

Chris Houser*, Shigeki Yokoi and Takami Yasuda****
**Kinjo Gakuin University, Omori 2-1723 Moriyama-ku Nagoya 463-8521 Japan,*
houser@kinjo-u.ac.jp
***Nagoya University, Furo-cho Chikusa-ku Nagoya 464-8601 Japan*

Japanese children spend hundreds of hours, over nine years, studying some 2000 written characters called *kanji*. Incredibly, most foreign adults attempt to study the *kanji* using the *same* method. But without these hundreds of hours, their efforts generally fail. In *Remembering the Kanji*, James Heisig presents a radical method for studying *kanji*. In only 200 hours, Heisig claims, adults can learn the *kanji*. A wonderful improvement! But few students follow his method; most complain that 200 hours is still too long. This paper introduces a refinement of Heisig's technique, a refinement combining modern memory theory with software, a refinement reducing the required time to 40 hours. The first author, a forgetful *kanji* neophyte, learned the *kanji* with this method, studying an hour a day, five days a week, for two months. His recall exceeds 95%, approximating native Japanese. This paper targets both teachers and students of Japanese as a foreign language, providing the knowledge and software required to rapidly learn the *kanji*, and inviting them to participate in a wider experiment using these new technologies.

Keywords: **CALL, Kanji, SuperMemo, Efficient study**

1 The *Kanji*

Perhaps the most difficult part of learning Japanese is memorizing its enormous character set: the 2000-odd *kanji*. These characters were imported from China into Japan. Because each character was imported several times over the centuries, while the Chinese and Japanese languages were evolving, each character now has multiple readings and meanings. As a result, the Japanese writing system is arguably the world's most complex.

Japanese children study these *kanji* for hundreds of hours over nine years of schooling. They start studying when six years old, before they have developed the ability to abstract, and hence can learn the characters only by *muscle memory:* They write the characters repeatedly, typically 20 times each. This method works, but imperfectly: Even after all this study, and the review that comes with daily use, adult Japanese forget some characters.

Most foreigners studying Japanese as a foreign language (JFL) try to learn the *kanji* using the same method: They write the characters repeatedly, perhaps while verbalizing the character's meanings and readings [7]. But since few adult JFL students have the hundreds of hours this method requires, most fail [4].

2 Heisig's method for studying the *kanji*

Heisig [4] offers an alternative study method.
Goal. Heisig's method allows adult JFL students to learn the *writing* and a *single meaning* of 2042 *kanji*. This is a narrow goal: Students concentrate on learning this writing and single meaning, and postpone learning other meanings, all readings, and the multiple character compounds.
Method. Since Heisig targets adults, he is able to use a sophisticated method, a method beyond the grasp of six year olds. He is able to use a *rational* method for learning *kanji*. Heisig prepared his method by

1. assigning each character a *keyword* (its single meaning),

2. splitting each character into a handful of *parts,*
3. ordering the characters so that parts precede their uses, and
4. inventing a mnemonic story to help recall each character's parts.

The keyword is usually the most common of the several Japanese meanings. The parts come from various sources: Some are simpler *kanji*; others are *primitives* – collections of commonly occurring strokes. Some of these primitives were identified centuries ago by Chinese and Japanese linguists (who call them "radicals"); other primitives were simply invented by Heisig. In all, Heisig uses a few hundred parts. The crux of his method:

Each character is learned, not as a mass of random strokes, but as a logical collection of parts.

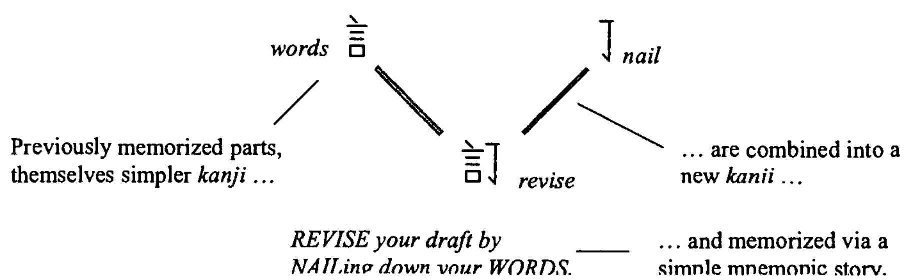
For example, consider the kanji with the keyword revise. This character has **nine meaningless strokes**, which prove quite a challenge to remember. But this same character has only **two parts** with the keywords *words* and *nail* – **meaningful** words which are much easier to remember. In effect, Heisig splits this character into these two parts, making a kind of equation: *revise = words + nail.* Most non-Japanese find this equation much simpler to recall than a meaningless jumble of nine strokes. When Heisig's students come to study *revise,* they have already learned the two parts – *word* and *nail* – since Heisig has sorted the *kanji* so that these parts precede their use in *revise.* By combining two previously learned parts, students easily remember this new character. But Heisig makes remembering even easier by providing a **mnemonic story**:

REVISE your draft by NAILing down your WORDS.

The image of "nailing down one's words" is so strong and logical that after students have read this mnemonic **once**, they will likely remember it for life.

This contrasts with Japanese students, who practice **writing** the character **repeatedly,** and may later forget it.

Heisig's main contribution is to **raise the level of abstraction** from strokes to parts. Rather than struggling to remember a large, sprawling jumble of meaningless jots and dashes, students effortlessly remember a simple story, calling to mind the few parts that compose a *kanji*:



Study. Heisig has done most of the work: He has assigned the keywords, identified the parts, invented the primitives, and sorted the *kanji.* Students need only read the keyword and story a few times to memorize each *kanji.* Heisig predicts study will require 200 hours – far less than Japanese children spend on rote repetition.

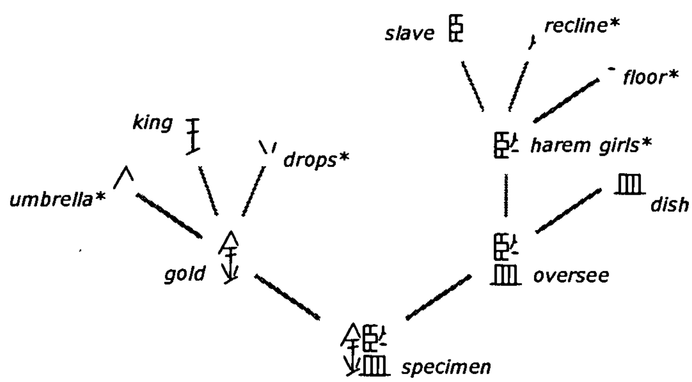
Analysis. Why is Heisig's method so effective? Here are three explanations.
Simplicity. The stories are simpler than the *kanji*, simpler because they have fewer components. Each *kanji* consists of between 1 and 23 strokes; 75% of the *kanji* have more than seven strokes. But all have fewer than seven parts. Now human short-term memory can hold only about seven items [6]. Objects with more than seven known components cannot fit in short-term memory, and so cannot be remembered, or even recognized. This predicts that students learning strokes will remember 25% of the *kanji*, but students learning parts will remember 100%.

Abstraction. Practicing strokes engages only muscle memory: Most of the student's brain remains dormant. Heisig's stories engage the higher faculties of language, actions, settings, events, humor, and metaphor. Such meaningful symbolic processing engages more of the brain, and hence is more easily recalled, than mere orthographic syntax [8]. Humans recall abstract meanings and stories long after they forget specific examples and images [5].

Relations. When learned by rote, each *kanji*, indeed each stroke, must be learned anew: Nothing is connected to anything else. When learned by parts, each *kanji* is connected to previously learned *kanji.*

Heisig's method is rich in connections. When students learn a character, they are also reviewing its parts. In turn, most parts appear repeatedly, and hence are memorized easily.

As an illustration, consider the daunting 23 strokes of *specimen.* Stroke-by-stroke memorization is all but impossible. But *specimen* comprises only two parts: *gold* and *oversee.* It is easily recalled with a story such as *GOLD diggers OVERSEE their mineral SPECIMENS. Specimen* is studied after *gold* and *oversee* have been learned, from their own parts, with their own stories. So each step of study is small and simple, but the steps build on each other – primitives are woven into *kanji*, which are in turn used to build further *kanji* – until a vast web of rich connections is built up in the student's mind.



Parts are either simpler *kanji*, or *primitives* (marked with *)

Problem: Still too difficult! Heisig's method is a great improvement over the Japanese method, but it is not perfect. For Heisig provides stories for only the first 500 of his *kanji*, and asks readers to invent their own stories for the remaining 1542. Faced with this burden, many of Heisig's students stop studying after 500 characters. And those who do continue need unusual discipline, need to painstakingly construct and review flash cards, need a scheduling system to study, review, and test.

3 Kanji Can

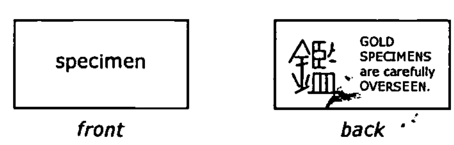
Kanji Can [3, 1] is a database with a *complete* set of 2042 mnemonic stories. The stories are excellent, surpassing even Heisig's first 500:

- Kanji Can's stories are shorter, and so easier to recall.
- Kanji Can's stories mention the parts in the order they are written.
  (Compare with Heisig's story for *revise* above, which reverses them.)

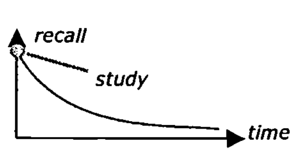
Kanji Can embraces Heisig's method, but extends his materials, and thus solves the problems mentioned above.

4 Flash Cards

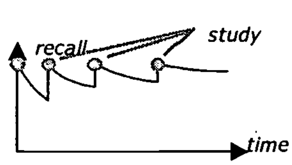
The chief tool of most memorizers is the humble flash card. Flash cards are small paper cards with a *stimulus* written on the front side, and a *response* on the back. When studying foreign language vocabulary, the stimulus is typically a word in one's native language, and the response is the word in the foreign vocabulary. When studying *kanji* using Heisig's method, the stimulus is the keyword, and the response is the *kanji* itself.



Students read the stimulus and try to produce the response. They then check their response against the desired response on the back of the card. Cards that were correctly recalled are removed from the deck; cards not recalled are shuffled to the back of the deck, to be reviewed again. Used this way, flash cards combine self-testing with review. The cards catch mistakes and save them, allowing review until the student knows them all. Flash cards



Memory fades after



Repeated study slows

are essential when following Heisig's method: Studying the stories is so easy that students will doubt they are really learning anything until they have been tested!

Problem: Inefficiency. Using flash cards takes a lot of time. Each card must be hand made. Then each card must be tested repeatedly, for only with repetition comes dependable memorization. Memory fades over time, but by reviewing partially forgotten material students extend their memories.

But how frequently should students review? Buzan [2] recommends review after ten minutes, a day, a week, a month, and then four months. But are these the best intervals for review? Testing too frequently wastes time reviewing material already well known. Testing too infrequently wastes time relearning forgotten material. The goal of flash cards is to "catch" learners just before they fall – to remind them just as they are about to forget. But the point of forgetting – and hence the optimal review interval – differs for each student, and even for each *kanji*: Some are easier to remember than others. How can we optimize study?

5 Super Memo

Super Memo is a general flash card program [9]. Like paper flash cards, these electronic cards can be used to review anything, including the *kanji*. Unlike paper cards, these electronic cards are neat and easily editable, but require a PC. Super Memo is better than paper flash cards because it contains a mathematical model of human forgetting: It can predict when a student will forget a *kanji*, and hence compute the best testing time. When testing with Super Memo, students tell the program how well they remember each *kanji*; the program uses this information to tune its model to each student, and to each *kanji*. The result closely approximates perfectly timed intervals, and hence maximum efficiency in studying.

Independent of the nature and amount of material they study, students using Super Memo all learn approximately 200 items/minute/year. This means that by studying one minute, every day, for a year, one can learn 200 items; or, by studying 10 minutes a day, 2000 items. This is much faster than many other study methods; in particular, Super Memo implies results in 1/5 of Heisig's time.

Super Memo's computerized scheduling provides more than optimal reviews. It also provides an incentive to study every day. A student using Super Memo runs the program every day and finds a list of items to review. If the student skips a day, the next day she will be confronted with twice as many items! This threat helps provide the discipline necessary in learning a large body of material, such as the *kanji*. (Unfortunately, this also means that if the student skips a week, she will be confronted with a mountain of review, and will likely quit altogether. Super Memo is not for the timid.)

6 New technology allows learning the *kanji* in only 40 hours!

This paper proposes a new method for learning the *kanji*, a method combining Heisig's novel ideas, Kanji Can's stories, and Super Memo's reviewing. Heisig provides the tractable goal and the idea of using mnemonic stories to recall the writing of *kanji* in terms of their parts. Kanji Can provides a complete set of these mnemonic stories. And Super Memo provides strict scheduling and efficient reviewing and testing. The combination of these three educational technologies provides a most efficient *kanji* learning method: the complete set of 2042 *kanji* can be learned in only 40 hours!

These 40 hours might be scheduled as 10 minutes a day, every day for a year, or an hour a day, five days a week, for two months. Memory manuals claim that an hour's study a day is optimal: Shorter study sessions waste time in frequent physical and mental preparation, longer study sessions induce fatigue, and both degrade efficiency [2, 5].

The first author learned the *kanji* in 40 hours by following this method.

Heisig has greatly accelerated *kanji* learning for adult JFL students. Kanji Can's complete set of stories enables students to concentrate on studying the *kanji*. Super Memo provides a well-documented speedup for any rote memorization. Combining these three technologies, we can learn the *kanji* in only 40 hours.

References

[1] Breen, J., *KanjiDic*, ftp://ftp.cc.monash.edu.au/pub/nihongo/00INDEX.html (2000).
[2] Buzan, T., *Make the most of your mind*, Pan, London (1977).
[3] Donaghue, M., *Kanji Can*, http://www.kanjisoft.com (2000).
[4] Heisig, J., *Remembering the Kanji I*, Japan Publications Trading Co., Tokyo (1977).
[5] Maddox, H., *How to study*, Ballantine, New York (1963).
[6] Miller, G., "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information", *The Psychological Review,* vol. 63, pp. 81-97, http://www.well.com/user/smalin/miller.html (1956).
[7] Sakade, F., Emori, K., Friedrich, R., Ohashi, S., *A guide to reading & writing Japanese,* Charles E Tuttle, Rutland, Vermont (1959).
[8] Schmidt, U. & Geyser, A., "How to study 2000 kanji in a few weeks", *Proceedings of ICCE 99,* pp. 595-598 (1999).
[9] Wozniak, P., *Super Memo*, http://www.supermemo.com (2000).

A Study of Networked Constructive CAI System Using Multiplication-Concept of "Transformation of Unity Quantity" on Elementary School

Pou-Yah Wu*, Shu-Fen Tsai, Yao-Quan Li, Jian-Zhi Lin, Jun-Rong Chen, and Xiang -Ting Huang
Department of Mathematics Education, National Tainan Teachers' College
33, Sec. 2, Su-Lin Street, Tainan, Taiwan 700
**Pou-Yah Wu's email:pywu@ipx.ntntc.edu.tw*

The feature of networked constructive CAI system lies in shaping the computer environment in which students clarify and construct the concept by ways of communication, discussion, and dialectics, utilizing the practical pedagogic content edited by the spirit of new curriculum in Taiwan at 1993. Because we stress the concept of "transformation of unity quantity" as main activity in teaching multiplication, students' comprehension of "unity quantity", "unity number", and "combined numbers" plays an important role in establishing networked constructive CAI system. We consider that the greatest difference between the networked learning environment and that of the general classroom pedagogy is the deficiency of interaction. Thus, analyzing the strategy of students' solving problems to establish the effective tool table of operation and judging the mode of the students' thought by checking the tools which students use will strengthen the interactive relationship of the system and the learners. Then, use the networked technology and the principle of the expert system to set up the CAI of constructive pedagogy, so that the learners can communicate with each other and the system can conduct dynamically which formally construct a wholly co-operative learning environment and will help the learners to form the whole mathematics concepts.

Keywords: **Constructive pedagogy, Elementary School, Multiplication of Mathematics, Networked CAI.**

1 Introdution

The characteristic of implementing new curriculum of mathematics at elementary schools in Taiwan now lies in the addition of spirit of constructivism, aiming at expecting students to construct knowledge positively. Thus, the teachers' role, in the process of pedagogy in new curriculums, changes into "problem poser", whereas students' learning activities in class attain socialized mutual sense, chiefly by communication, construct their own mathematical knowledge by way of mutual dialectics [5,6]. However, it takes pedagogy of construction longer than traditional pedagogy. The atmosphere and skill as to how the teacher directs students to construct knowledge and how the students discuss influence the effect of implementing new curriculum. In the light of the fact the trend of the times facilitates pedagogy of network to become widespread, the future construction of leased network lets us expect the popularity of "learning at home" and "long distance pedagogy". Therefore, the possibility of displaying a really approximate leaning setting of constructing pedagogy in the network environment becomes much higher. The establishment of the network system of pedagogy of construction, owing to the trend of current situation, is becoming imminent.

The aim of this study consists in designing a learning environment of network suitable for "multiplication concept in elementary school" . The greatest difference between the learning environment of network and that of the general classroom is the deficiency of mutual response [22,26]. And the pedagogy of construction hopes the communication and dialectics to bring about reflection, inspiring students to construct mathematics self-concept. Therefore, how to promote the mutual relationships between the system and the user is one of the considered points about constructing system in this study. Furthermore, how to develop the characteristic of pedagogy of construction in the system and how to make the pedagogic contents of the new curriculum manifested in the system wholly and fluently is the second chief point taken into account. Aimed at the above two points, that we use network technology, letting the real-time communication proceeded between the learners, or between the learning and system make up a wholly cooperative learning environment. Furthermore, making use of the principles of the expert system to deal with the learning strategy of the problem solver, through the concepts manifested by the problem solver, the system will feedback suitably, and will communicate with the students properly, which can make the pedagogic activity proceed dynamically [19,25]. The design of the pedagogic content, expect considering the sprit of the new curriculums, the students' learning state, after the teachers' real pedagogy, is mainly considered about designing pedagogy. Hence, this system is much closer to the real situation of pedagogy them CAI sold in the market. And the activities of problem solving given to the learner by system would be more congenial to the learner's mode of thought.

2 Principles of system constructing

2.1 Base of learning theory

"Knowledge is positively constructed by the learner rather than being inculcated passively from outside," which is the fundamental proposition of constructing pedagogic paradigm. The students, with acquired knowledge, enter another stage as an active subject of recognition, with good theory by themselves, instead of ignorance and irrationality [16]. But pedagogy of construction does not mean the teacher's role is unnecessary. On the contrary, we realize the aim of pedagogy is to make children construct the activity types of solving problems. In the light of this, the teachers' role becomes "problem poser" rather than "problem solver" in the process of pedagogy. By way of the teachers' posing problems, children undertake the activity of solving problems by themselves; or children become "imitators" through the activity of solving problem provided by the teacher [4]. By these processes, students are provided sufficient experience of solving problems, and then construct the correct mathematics conceptions. Besides, what we must also pay attention to is the teacher and the learner grasp the intentions of each other aiming at the proceeding actives of each other, through trial and dialectics, until both of them relieve the pressure aroused by the interchange actives. The relief of pressure is limited by the fact if the problem is solved according to the activity, and is also influenced by the affectionate expression of them both present of them both present [24]. Therefore, in pedagogy of construction, socialized communication is an important feature [3].

2.2 Base of system establishing

This system is a learning environment constructed in the network, adopting three-tier client/server system architecture: that is, adding another service server on the original framework of the two-tier client/server system in this three-tier client/server system architecture, the management of Database Server charges learning data. Web Server is responsible for teaching, whereas the user of Client precedes all kinds of learning activities ivies through browser machine.

3 Pedagogic design of Multiplication using transformation of unity quantity

3.1 Concept of multiplication

Multiplication referred to by Davydov (1991) is the problem of transformation of unity quantity, that is, the transformation from composite unit to that of the single item [20]. And Clark and Kamii (1997) think that if children own the multiplicative thinking, they will simultaneously deal with lower level unit such as unit of one and the higher level unit different from unit of one [18]. Tzyh-Chiang Ning (1994) mentions that the so-called multiplication operation contains at least two kinds of relationship: (1)the coordinating relationship of two levels,(2)the part-whole relationship of two levels. The problem of multiplication is in reality that of the transformation of unity quantity, namely, the problem of transforming quantity from higher level unit to lower level unit [7,8,9].

3.2 Pedagogic design of multiplication using transformation of unity quantity

The recognition of new curriculums toward mathematics concepts specifies the activity types of solving problems of interiorization [17,23,26]. And he origin of mathematics knowledge embodies the activity of solving problems, instead of tangible objects [5]. Thus, the ideas of new curriculum do not emphasize the existence of calculating problems. The generation of all forms of calculation is entirely for the need of the practical contexts; also the measurement serves as the source of multiplication in the practical contexts [20]. Hence, the appearance of new curriculums in pedagogic content lets students have the necessary sense of owing multiplicative thinking rather than multiplication directed by "multiplication table" of old curriculums; whereas "transformation of unity quantity" is the pivotal point in designing teaching material of new curriculums, different from the viewpoints that look upon multiplication as "repeated addition" [21] in the design of multiplication of old curriculums. In other words, students' comprehending "unity quantity", "unity number" and "combined numbers" in the process of solving problems plays an important role in the design of material content of new curriculums. Tzyh-Chiang Ning (1993) [8]mentions that there are three classification of difficulty in the management of initiatory material of multiplication in new curriculums:(1)the students can tackle the problem of transformation of unity quantity (2)the students can solve and record the process of solving problems concerning about transformation of unity quantity,(3)the students can describe the record of the problem of transformation of unity quantity by multiplication sign. Therefore, in the design of pedagogy of multiplication, the arrangement of new curriculums lies in the fact the teacher set up a problem of multiplication in the practical contexts, and the students handle and record the problem by themselves after conveying the message of the problem. The students' knowledge is chiefly constructing from the consultation, inquiry and dialectic between the teacher and the peers; via the established learning by the concept of constructive pedagogy, the teacher should, in the process and record of the students' solving problems, help the students clarify the existence of "unity quantity", "unity number", and "combined numbers" in the problems. The students should also attain the unanimous compromise of the format of record; that is, the format of the students should wholly suggest "unity number ", "unity number", and "combined numbers". When the process of pedagogy arrives here, students have at least finished the level of the second difficulty mentioned by Tzyh-Chiang Ning. As to the application of multiplication sign, it is the flowing and economic problem of culture and communication. New curriculums, thus, undertake such a linguistic transformation of "a×b=>a lots of b=>b multiplied by a." and then bring multiplication sign serving as the operator of recording format. If the students can make use of multiplication symbol as the operator in the recording format, we may well say that they attain the level of the third difficulty. While the students reach that level, they are equipped with initiatory concept of multiplication; in other words, arrive at the formation of " multiplication" concept gradually through "experience"," perception" and "realization" [4].

4 Simulation of the process in the constructive pedagogy

Since our CAI system stresses the spirit of the constructive pedagogy, we hope that the whole computer environment would become more compatible with the real environment of pedagogy. What we must emphasize is the teacher himself/herself is the most important natural resource in the environment of pedagogy. All our set CAI would attain is how to let the computer simulate the mode of thought in the teachers' real lecturing, even to let the computer "realize" the mode of the students' thought. With a view to achieving such an effect, we design operation tools for users' use. We can discriminate the stages of students' thought by the users' choosing tools, which will let the computer analyze the students' mathematics competence through the stage of the students' operation, and simultaneously let the computer carry on dialectics, clarification and discussion by simulating the role of the teacher or that of the student. We can achieve a process of socialization on the computer by such a process of the design. And via such a process, the user can "experience"," observe", and "realize" the concept of multiplication, and finish three tasks of the stages: (1) the students can tackle the problem of transformation of unity quantity (2) the students can solve and record the process of solving problems concerning about transformation of unity quantity,(3)the students can describe the record of the problem of transformation of unity quantity by multiplication sign. Take Figure 1 as an example, students can move the bone to the bay by the mouse, then the computer system may judge whether does he/she understand the meaning of problem. We hope to make students gain more self-affirmation by manipulating. As show in Figure 2, our system provides the electric board and the tool table. User can simulate the situation in the class to solve the problem and record the format. In additional, system also supports the different operation tools for users. And the system can provide different solving method to help users constructing their operation by judging what kind of tools they choose. The system also can judge users' operation mode by checking their record format, then, the system will master students' learning condition well, and teach dynamically. Besides, the system also provides virtual students to communicate with users as showing in Figure 3. It will increase the users' learning interest. Virtual students that design for guiding user and make the environment of discussion can provide proper help but not answers in fitting time.

5 Architecture and implementation of system

5.1 Environment of design and tool

This system uses Windows NT server as server. Developing languages include HTML, JavaScript, Active X, ASP (Active Server Page) and so on. ASP is used as the chief method of control, and ASP and ODBC (Open Database Connectivity) are exercised to match. The management of the teaching material's user becomes simplified. As to the edition of the curricular software, Authorware 5 is mainly used for developing tools.

5.2 Process of system

Process of the system we designs just as Figure 4 shows, the general elucidation is as follows,

1. Pedagogic situation of network construction

The system after the analysis of the pretest makes sure the sorts of the user's operation and then to pose problems according to the classification. The system will communicate and clarify the messages of the problems by the tools in tool table. After the sorts of tools by user to discriminate if he/she has grasped the messages of the problems, the system will provide tool table further, letting the user record by the tools. In this stage, along with level of the user's operation, the system will afford problems, via simulating the role of the student or the teacher to carry on the activities of dialects, clarification, and let the user reflect and modify his/her recording format to match the basic requirements of "unity quantity", "unity number" and "combined numbers" suggested in the recording format". Afterwards, adjust the next learning activity according to the learning state of the user until he/she can construct the concept of multiplication on the acquired basis and attain the learning level of the afore-specified third difficulty. Besides, the system can simulate the real learning environment on the network, letting the user's learning environment diverse.

2. 「Student model」 database

Student model consists mainly of three databases:

(1) Student basis database

It chiefly records the students' basis data such as name, age, the experience of using computers and so on.

(2) Database of learning.

It records the unit of teaching materials the student learned, the learning state of each unit and the duration of time, and the positive result of the students' learning.

(3) Database of learning achievement.

It records the students' assessment about answering and the stage of operation.

3. Database about "posing problems of constructive pedagogy"

The content of teaching material about constructive pedagogy include

(1) Phenomenal problem: this sort of problem can facilitate students to "experience" the mathematics concept.

(2) Psychological problem: this sort of problem can facilitate students to "observe" the mathematics concept.

(3) Sociological problem: this sort of problem can make students via discussion; attain the common sense of using recording, which would become the tool of communication.

(4) Anthropologic problem: this sort of problem can make the above – mentioned communicating tools and the correspondent expression in cultural become congenial.

4. Database of " problems"

This database is to store the problems for the pretest and the posttests.

5.3 Function of on-line communication

The system would establish a learning environment more congenial to real teaching situation thus the convenience for the user and for other users on the line to communicate, thereby setting up a network environment for undertake cooperative learning. The system designs a series of functions for on-line communication on the line, illustrated as the followings.

(1) Group of discussion

Group of discussion is an open but not synchronized function on the line. When the user encounters the difficulty in learning, he/she put up his/her questions in the group of discussion, letting other users put forth solutions to these questions.

(2) Room for discussion

As showing in Figure 5, the function of the room for discussion can improve the disadvantages of the personal computer learning CIA's failure to carry on communication, real-time discussion to a large extent, for it is an open and synchronous for communication. Besides calling the virtual teacher or student, the user can enter the room for discussion for help when he/she needs others' help to solve the questions.

(3) On-line Call

On-line call may be inputted simple information to communicate with other on-line users.

5.4 The operating process for the user on the system

When the user enters the system with the browser for the first time, the system will ask he/she to register as showing in Figure 6, thereby acquiring the basic data to establish the Database for "student model", and simultaneously letting the user accept pretest to discriminate the levels of the user's operation, and recording the situation of their answering, and the connection of active modification letting the user join the curricula suitably.

Afterwards, whenever the user enters the system, he/she must key in user name and password to make sure the identification. The system will continue the following activities according to the previous record of the user. The system would record each learning activity the user undertakes one by one, with the view of analyzing the fact if the learning state of the user will attain the expected aim. When the user encounters the line provided by the system: he/she can also check his/her learning state at any moment to grasp the learning progress.

6 Conclusions

The age of computer is that of knowledge explosion indeed. Undoubtedly, "Self-learning" is the best way to enrich self in the age of widespread information. With network becoming so widespread, it is not uncommon for the students of the elementary school to enter the network. It is incumbent on us to let the teaching environment of CAI congenial to the concepts of teaching nowadays. We hope our CAI system will become compatible with the social need now, breaking through the limitation of time and space and overcoming the barriers of learning environment now, giving the learner more space to exert himself/herself. At present, this system has finished the prototype, and plans to precede real teaching experiments and systematic assessment in a few months.

Reference

[1]周筱亭, "數學新課程的趨勢", 研習資訊, Vol. 11, No. 3, pp. 28-50, (1994).

[2]侯志欽, "教學設計的哲學省思—由客觀主義到建構構主義", 國民教育集刊, Vol. 17, pp. 221-229, (1999).

[3]甯自強, "「根本建構主義」—認知研究的另一種架構", 師友月刊, 12 月號, pp. 30-32, (1987).

[4]甯自強, "經驗、察覺、及了解在課程中的意義—由根本建構主義的觀點來看", 論文發表於國立台東師範學院八十一學年度國小理科教育學術研討會, pp. 191-197, (1992).

[5]甯自強, "國小數學科新課程的精神及改革動向—由建構主義的觀點來看", 科學教育學刊, Vol. 1 No. 1, pp. 101-108, (1993).

[6]甯自強, "「建構式教學法」之教學觀—由根本建構主義的觀點來看", 國教學報,Vol. 5, pp. 33-41, (1993).

[7]甯自強, "單位量的轉換（一）正整數乘除法運思的啓蒙",教師之友, Vol. 34, No. 1, pp. 27-34, (1993).

[8]甯自強, "新課程對乘法啓蒙教材的處理", 論文發表於國立嘉義師範學院八十二學年度數學教育研討會, 四月二十九日, (1994).

[9]甯自強, "單位量的變換（二）—正整數乘除運思的融合", 教師之友, Vol. 36, No.5, pp. 35-44, (1995).

[10]甯自強, "數學的格式與內容—皮亞傑對維高斯基", 論文發表於台北市立師範學院「皮亞傑及維高斯基的對話」百年校慶學術研討會, 元月二十五、六日, (1996).

[11]甯自強, "劉裕誠的數概念", 1997 海峽兩岸幼兒教育學術研討會論文集, pp. 167-185, (1997).

[12]甯自強, "涂景翰的數概念", 科學教育學刊, Vol. 6, No. 3, pp. 255-269, (1998).

[13]甯自強, "顏淑茹的數概念", 國教育研究學報, Vol. 4, pp. 231-264, (1998).

[14]羅清水, "認知心理學理論對電腦輔助教學設計發展與成效之影響", 研習資訊, Vol. 15, No. 1, pp. 1-15, (1998).

[15]鐘靜, "從疑難問題談乘法文字題教學", 國教月刊, Vol. 36, No. 9,10, pp. 33-35, (1980).

[16]蘇育任, "建構主義式的教育的迷思與省思", 國民教育集刊, Vol. 5, pp. 121-139, (1997).

[17] Bridgaman, P. W.," The way things are", New Your: Viking Compass, pp. 83, (1959).
[18] Clark, F. B. & Kamii, C., " Identification of multiplicative thinking in children in grades 1-5", "Journal of Research in Mathematics Education", Vol. 27, No. 1, pp. 41-51, (1996).
[19] Dalgarno, B., "Constructivist Computer Assisted Learning: Theory and Techniques", http://services.Canberra.edu.au/~barney/articles/ascilite96/paper.htm (accessed on Oct. 21, 1997).
[20] Davydov, V. V., "A psychological analysis of the operation of multiplication", In L. P. Steff (Eds.), Psychological abilities of primary school children in learning mathematics, Soviet Studies in Mathematics Education Series, volume 6, pp. 9-85, (J. Teller trans.) Reston, VA: NCTM. (1991)
[21] Fischbein, E., Deri, M., Nello, M. S., & Marino, M. S., "The role of implicit models in solving verbal problems in multiplication and division", Journal of Research in Mathematics Education", No. 16, pp. 3-17, (1985).
[22] Hiltz, S. R., " Teaching in a Virtual Classroom", http://it.njit.edu/njIT/Department/CCC/VC/Papera/Teaching.html (accessed 1995).
[23] Piaget, J., "The Psychogenesis of knowledge and its epistemological significance", In M. Piatelli-Palmarini (Eds.), Language and learning: The debate between Jean Piaget and Noam Chomsky, Cambridge, MA:Harvard University Press, (1980).
[24] Steff, L. P. & Wood, T. (Eds.), " Transforming Children's Mathematics Education: International Perspectives", Hilsdale, NJ:LEA, (1990).
[25] Squires, D., "Can multimedia support constructivist learning?" http://www.spirit.net.au/ACEC96/papers/squir.htm (accessed on Oct. 21, 1997).
[26] Van Engen, H., "An analysis of meaning in arithmetic I & II", The elementary School Journal, pp. 321-329 & 395-400, (1949).
[27] Webb, G., " A Theoretical Framework for Internet-Based Training at Sydney Institute of Technology", http://ausweb.scu.edu.au/proceedings/webb/paper.html (accessed on July 5-9, 1997).

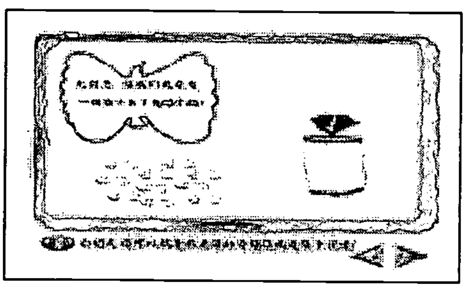


Figure 1:The clarification of the problem

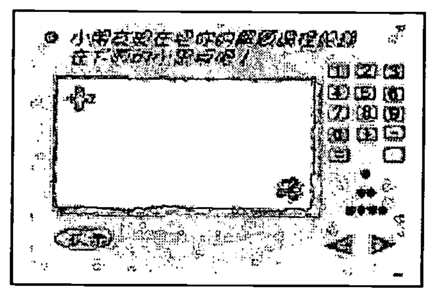


Figure 2: The electric board and tool table

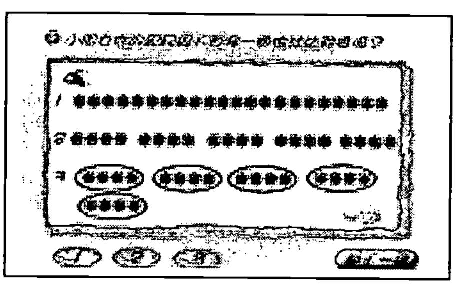


Figure 3:The strategies of virtual students

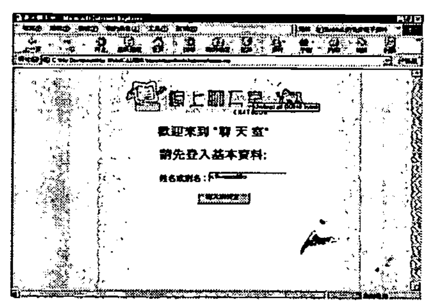


Figure 5:Room for discussion

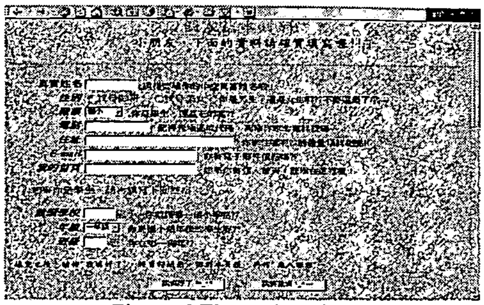


Figure 6:The registration

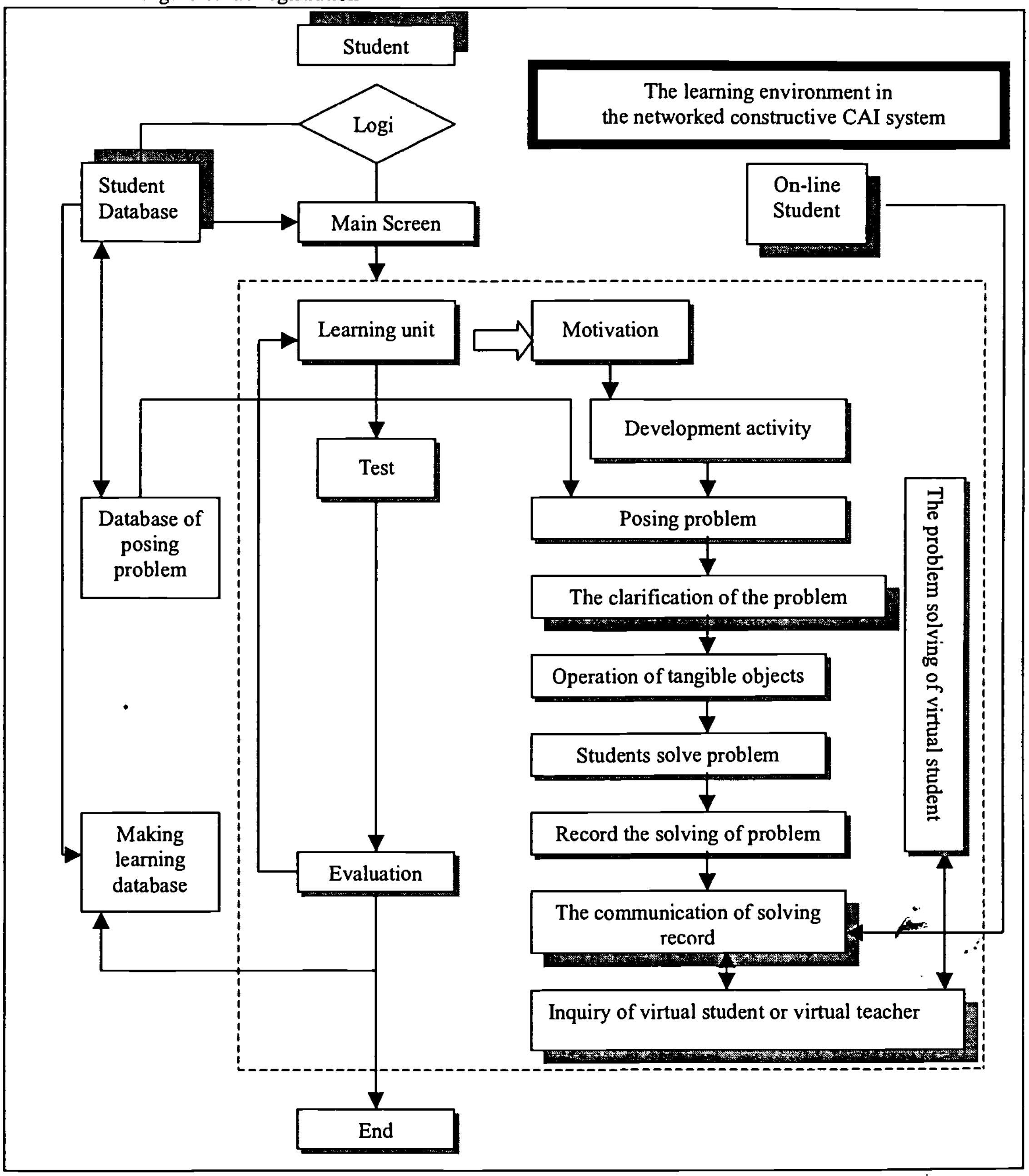


Figure 4: System flowchart

A Study on the Relation between Touch-typing Skill and Thinking-typing

Yuji YOHINAGA* and Hiroaki KAWABATA**
The Graduate School of System Engineering, Okayama Prefectural University
111 Kuboki, Soja, Okayama, 719-1197, Japan
*E-mail: *yoshinaga@mx3.tiki.ne.jp **kawabata@cse.oka-pu.ac.jp*

Word processor is more and more widely used as a tool of externalization and reflection of thinking in recent years in Japan. In that case, it will be necessary to type smoothly words or sentences appearing in the head (hereinafter referred to as "thinking-typing"). The experiments were made to study the relation between touch-typing skill and thinking-typing. The examinees were 46 non-computer majors of the university. The students were asked to type words or sentences appearing in their heads on 3 subjects. The touch-typing skill of the students was measured by touch-typing exercise software. The results suggested that a touch-typing speed of 2 strokes/second is necessary, at least, to type smoothly words or sentences appearing in the head. What's more, the results of the experiments suggested that learning of touch-typing skill is very effective on the increase of thinking-typing speed of the subject that is easy to be thought out.

Key words: **Thinking-typing, Touch-typing, Externalization, Self-evaluation, Analysis of variance**

1 Introduction

The methods for human beings to externalize their thinking are language expression, diagram expression, letter expression and so on [1]. Among these expressions, letters are widely expressed by word processors in recent years in Japan. The method of word processor's usage has been changed by the popularization of them. In other words, the method that uses a word processor to transcribe a manuscript written by handwriting, has been changed to the method that uses a word processor in the process of externalization and reflection of thinking. With the latter method, it is necessary to type smoothly words or sentences appearing in the head (hereinafter referred to as "thinking-typing"). Thinking-typing needs a certain level of typing skill. Although a number of studies have been made on typing [2] [3], there are few studies on thinking-typing.

In the lesson of computer exercise at the university, the first author is raising the level of students' typing skill through touch-typing education and, at the same time, is raising the ability of the students' utilizing a word processor as a tool of externalization and reflection of thinking [4]. In the lesson, the experiments of thinking-typing by touch-typing were made to study the relation between touch-typing skill and thinking-typing. Touch-typing speed and self-evaluation of thinking-typing were adopted as the scale of thinking-typing level. The first experiment (Experiment 1) was made in July, 1999, and the second experiment (Experiment 2) was made in February, 2000. In this paper, results regarding Experiment 2, and comparison between Experiment 1 and Experiment 2 are reported, because results regarding Experiment 1 had been reported already [5] [6].

2 Method

The experiments of thinking-typing by touch-typing were made in the lesson of the computer exercise for the first-year students at the university. In this study, the data of 46 students, whose data of Experiment 1 and Experiment 2 were complete, were analyzed. In the experiments, the students typed the following subjects by touch-typing.

【Subjects of Experiment 1】

Subject 1: Type words that you think with *shiritori* (a Japanese word chain game). Type them by *hiragana* (Japanese alphabet). The time limit is 3 minutes.

Subject 2: Type words that you image with "university". Type them by *hiragana-kanji* (Japanese alphabet – Chinese characters) translation. The time limit is 5 minutes.

Subject 3: Type sentences of your self-introduction. Type them by *hiragana-kanji* translation. The time limit is 10 minutes.

【Subjects of Experiment 2】

Subject 1: Same as Subject 1 of Experiment 1.

Subject 2: Type words that you image with "student life". Type them by *hiragana-kanji* translation. The time limit is 5 minutes.

Subject 3: Type sentences of your impression about the lesson of the computer exercise. Type them by *hiragana-kanji* translation. The time limit is 10 minutes.

After the experiment, the students evaluated themselves on the 3 subjects. In Experiment 2, the students evaluated themselves on whether they could think out words and sentences or not (thinking evaluation), whether they could type words and sentences by touch-typing or not (typing evaluation). The evaluation standard was divided into 6 levels: "very good", "good", "a little good", "a little bad", "bad" and "very bad".

The touch-typing skill of the students was measured in the lessons before and after the lesson of the experiments. The measurement content is testing typing time of entering Japanese sentences of *hiragana* (about 240 strokes) that were displayed in a monitor at random, by *romaji* (Japanese Roman characters) input and touch-typing.

3 Results and Discussion

3.1 Relation between Touch-typing Skill and Thinking-typing Speed

Touch-typing skill in Experiment 2 was divided into 4 levels: under 1 minute (Level under 1 minute), between 1 minute and 2 minutes (Level of 1 minute), between 2 minutes and 3 minutes (Level of 2 minutes), between 3 minutes and 4 minutes (Level of 3 minutes). The mean and the standard deviation of thinking-typing speed in each touch-typing level are shown in **Table 1**. Thinking-typing speed in each subject was calculated by the next equation.

$$s = \frac{L}{T}$$

s : Thinking-typing speed in each subject

L : Typing linage in each subject*

T : Time limit in each subject (minute)

*Number of letters per line, after *hiragana-kanji* translation, is 40.

Table 1. Touch-typing skill and thinking-typing speed

Touch-typing skill	Number of persons	Thinking-typing speed (linage/minute)					
		Shiritori		Imagination		Impression	
		M	*SD*	*M*	*SD*	*M*	*SD*
Level under 1 minute	6	1.13	0.25	0.65	0.16	1.07	0.14
Level of 1 minute	23	0.84	0.23	0.52	0.14	0.72	0.19
Level of 2 minutes	12	0.59	0.11	0.35	0.06	0.47	0.11
Level of 3 minutes	5	0.51	0.13	0.28	0.09	0.42	0.10
All the examinees	46	0.77	0.27	0.47	0.17	0.67	0.25

One-way analysis of variance was used to test for significant differences in thinking-typing speed among the 4 touch-typing levels. As a result, touch-typing skill had main effect in the 3 subjects(*Shiritori*: $F=12.46$, $df=3$, $p<.01$ Imagination: $F=11.31$, $df=3$, $p<.01$ Impression: $F=23.55$, $df=3$, $p<.01$). What's more, Tukey's multiple comparisons test was applied to identify whether there are significant differences in thinking-typing speed among the 4 touch-typing levels or not. The results are shown in **Table 2.** Homogeneity subgroup is a group of similar levels whose difference is not significant. In the 3 subjects, there were significant differences of thinking-typing speed between the level under 2 minutes and the level over 2 minutes. These results show that reaching touch-typing level under 2 minutes in Experiment 2 was one of the conditions to type smoothly words or sentences appearing in the head.

Tabel 2. Tukey's multiple comparison of thinking-typing speed

	Touch-typing skill	Number of persons	Homogeneity subgroup		
			Gr1	Gr2	Gr3
Shiritori	Level under 1 minute	6	1.13		
	Level of 1 minute	23		0.84	
	Level of 2 minutes	12		0.59	0.59
	Level of 3 minutes	5			0.51
Imagination	Level under 1 minute	6	0.65		
	Level of 1 minute	23	0.52	0.52	
	Level of 2 minutes	12		0.35	0.35
	Level of 3 minutes	5			0.28
Impression	Level under 1 minute	6	1.08		
	Level of 1 minute	23		0.72	
	Level of 2 minutes	12			0.47
	Level of 3 minutes	5			0.42

p .05 *f*

3.2 Relation between Touch-typing Skill and Self-evaluation of Thinking-typing

Self-evaluation of Experiment 2 was divided into positive self-evaluation and negative self-evaluation to study the relation between self-evaluation and touch-typing skill. Positive self-evaluation is "very good", "good" and "a little good". Negative self-evaluation is "a little bad", "bad" and "very bad". As for self-evaluation point, positive self-evaluation is 1 point, and negative self-evaluation is 0 point. The mean of self-evaluation point of each touch-typing level is shown in **Table 3.**

Table 3. Touch-typing skill and self-evaluation

Touch-typing skill	Number of persons	Self-evaluation point					
		Shiritori		Imagination		Impression	
		Thinking	Typing	Thinking	Typing	Thinking	Typing
Level under 1 minute	6	0.50	1.00	0.17	1.00	1.00	1.00
Level of 1 minute	23	0.61	0.96	0.52	0.96	0.74	0.96
Level of 2 minutes	12	0.67	0.75	0.42	0.83	0.83	0.75
Level of 3 minutes	5	0.40	0.60	0.40	0.40	0.80	0.40
All the examinees	46	0.59	0.87	0.43	0.87	0.80	0.85

One-way analysis of variance was used to test for significant differences in self-evaluation point among the 4 touch-typing levels. As a result, touch-typing skill had main effect in the typing evaluation of imagination and in the typing evaluation of impression (typing evaluation of imagination: $F=5.11$, $df=3$, $p<.01$ typing evaluation of impression: $F=4.86$, $df=3$, $p<.01$). What's more, Tukey's multiple comparisons test was applied to identify whether there are significant differences about the typing evaluation of imagination and the typing evaluation of impression among the 4 touch-typing levels or not. The results are shown in **Table 4.** Typing evaluation of Level of 3 minutes in imagination was significantly lower than other touch-typing levels, and typing evaluation of Level of 3 minutes in impression was significantly lower than Level under 1 minute and Level of 1 minute. These results show that the students of Level of 3 minutes could not type smoothly imagination or impression, comparing with the students of other touch-typing levels.

Table 4. Tukey's multiple comparison of self-evaluation

	Touch-typing skill	Number of persons	Homogeneity subgroup Gr1	Gr2
Typing evaluation of imagination	Level under 1 minute	6	1.00	
	Level of 1 minute	23	0.96	
	Level of 2 minutes	12	0.83	
	Level of 3 minutes	5		0.40
Typing evaluation of impression	Level under 1 minute	6	1.00	
	Level of 1 minute	23	0.96	
	Level of 2 minutes	12	0.75	0.75
	Level of 3 minutes	5		0.40

p .05 f

3.3 Relation between Learning of Touch-typing Skill and Change of Thinking-typing Speed

The mean of learning ratio of touch-typing skill and the mean of change ratio of thinking-typing speed in each touch-typing level of Experiment 2 are shown in **Table 5**. Learning ratio and change ratio were calculated by the next equation.

$$\alpha = \frac{T1}{T2} \qquad \beta ? \frac{s1}{s2}$$

α : Learning ratio of touch-typing skill
$T1$: Touch-typing time of Experiment 1 (minute)
$T2$: Touch-typing time of Experiment 2 (minute)

β : Change ratio of thinking-typing speed
$s1$: Thinking-typing speed of Experiment 1 (linage/minute)
$s2$: Thinking-typing speed of Experiment 2 (linage/minute)

Two-way analysis of variance was used to test for significant differences in the 4 touch-typing levels and the 3 subjects about change ratio of thinking-typing speed in Table 5. As a result, main effect of the 3 subjects was significant(F=4.14, df=2, p<.05). Main effect of the 4 touch-typing levels and interaction were not significant. What's more, Tukey's multiple comparisons test was applied to identify whether there are significant differences in change ratio of thinking-typing speed among the 3 subjects or not. As a result, there were significant differences of change ratio of thinking-typing speed between Subject 3 and other subjects. Next, correlation between learning ratio of touch-typing skill and charge ratio of thinking-typing speed is shown in Table 6. A moderate significant positive correlation was observed between learning ratio of touch-typing skill and change ratio of thinking-typing speed in Subject 3. So it can be said that learning of touch-typing skill is very effective on the increase of thinking-typing speed of Subject 3. What is the qualitative difference between Subject 3 and other subjects? It is the easiness of thinking. Thinking evaluation point in Table 3 expresses the easiness of thinking in each subject. Thinking evaluation point of impression (Subject 3) is higher than other subjects. So it is considered that words of impression (Subject 3) was easier to be thought out than other subjects. Therefore, it can be concluded that learning of touch-typing skill is very effective on the increase of thinking-typing speed of the subject that is easy to be thought out.

Table 5. Learning ratio of touch-typing skill and change ratio of thinking-typing speed

Touch-typing skill	Number of persons	Learning ratio of touch-typing	Change ratio of thinking-typing speed Subject	Subject 2	Subject 3
Level under 1 minute	6	1.69	1.35	1.61	2.03
Level of 1 minute	23	1.58	1.24	1.47	1.93
Level of 2 minutes	12	1.57	1.18	1.57	1.61
Level of 3 minutes	5	1.50	1.89	1.47	1.80
All the examinees	46	1.58	1.31	1.51	1.84

Table 6. Correlation between learning ratio of touch-typing skill and change ratio of thinking-typing speed

	Change ratio of thinking-typing speed		
	Subject	Subject 2	Subject 3
Learning ratio of touch-typing	0.245	0.089	0.565**

**p .01 f

4 Conclusion

From what has been discussed about the relation between touch-typing skill and thinking-typing speed, and relation between touch-typing skill and self-evaluation of thinking-typing, it can be concluded that a touch-typing level under 2 minutes is necessary, at least, to type smoothly words or sentences appearing in the head. The speed of 240 strokes in 2 minutes equals 2 strokes/second. 2 strokes are needed to input a *hiragana*. So the speed of 120 *hiragana* in 2 minutes equals 1 *hiragana*/second. The aim of touch-typing education for thinking-typing should be set at 2 strokes/second (1 *hiragana*/second). What's more, from what has been discussed about the relation between learning of touch-typing skill and change of thinking-typing speed, it can be concluded that learning of touch-typing skill is very effective on the increase of thinking-typing speed of the subject that is easy to be thought out.

References

[1] Y. Saeki, "New Computer and Education", Iwanami Sinsyo, pp.104-105 (1997).
[2] T. Ohno, "The Effect of the Typing Skill for the Typing Process", Research Report of Information Processing Society of Japan(Human Interface), 63-6, pp.31-36 (1995).
[3] C. Kogo, "Use of electronic mail in assignments, term paper and final examination in college courses, and relationships between grades of them and typing skill", Research Report of Japan Society for Educational Technology Conferences, 96-4, pp.1-4 (1996).
[4] Y. Yoshinaga and H. Kawabata, "Touch-typing education in considering of self-evaluation", Proceedings of the 2000 IEICE General Conference(Information and System 1), p219(2000).
[5]Y. Yoshinaga and H. Kawabata, "A Experiment Report about Thinking-Typing by Touch-Typing", Proceedings of the Federation of Cyugoku Branch Electronics and Information 1999, pp.366-367(1999).
[6]Y. Yoshinaga and H. Kawabata, "A Study on the Effect of Touch-Typing Skill for Thinking-Typing", Advanced Research in Computers and Communications in Education(2), pp.833-834(1999).

An Assessment Framework for Information Technology Integrated Instruction

Chuan-Shih Wang* and Chia-Chin Li**
The Institute of Information and Computer Education, National Kaohsiung Normal University
116, Heping 1st Rd., Kaohsiung, Taiwan, R.O.C.
**jason@icemail.nknu.edu.tw **april@ icemail.nknu.edu.tw*

Information technology integrated instruction is the education tendency in the future, and it is also an important issue in the development of education in Taiwan. An assessment framework is needed during experimenting with integrated instruction and when integrated instruction is officially implemented. The framework can help us understand the implementation and provide information for future reference. This article proposes an framework for assessing information technology integrated instruction. The framework includes kernel and periphery parts. Kernel part refers to the whole teaching process, including information technology, curricula, learning materials, instructional strategies, learning activitïes, and evaluation. Periphery part refers to the surroundings situation, including teachers, students, information specialists, administrators, classroom settings, computer laboratories, campus instruction network, Internet, digital materials, and instruction/learning software.

Keywords: **information technology integrated instruction, technology integration, educational technology, evaluation**

1 Introduction

The rapid development of information technology (IT) has not only brought about major effect on economy and industry but also made a great impact on society and education. In particular, the prevalent use of computers and the rapid development of the Internet have gradually changed our life style and pattern, with their impact on education being unprecedented. Many educators and policy makers believe that technology can be a catalyst for educational reform [3,4,10]. They suggest that the use of technology in classrooms will shift the roles of teachers and students. Teachers will act more like facilitators by helping students access information, process it, and communicate their understanding [4].

Beginning the 2001 academic year, Taiwan will implement phase-by-phase the nine-year integrated curriculum for its elementary and junior high schools [11]. To cultivate students' basic ability to "apply technology and information", the new curriculum will have to emphasize integrating IT into the teaching of various courses. Amid this major reform of curriculum, the Computer Center of the Ministry of Education has planned for the integration of information curriculum with other areas of learning [7]. At the same time, it has selected 18 elementary and junior high schools in which teaching experimentations will be carried out [1]. Therefore, an assessment framework is needed during experimenting with integrated instruction and when integrated instruction is officially implemented. The framework can help us understand the implementation and provide information for future reference.

2 The essence of information technology integrated instruction

The United States has implemented IT integrated instruction for years. Many educators are now actively using technology along with effective teaching strategies to integrate technology into their curriculum [9]. In contrast, IT integrated instruction is still a newly heard noun in Taiwan. Many teachers are unfamiliar with it, and some think of it as another name for computer-assisted instruction (CAI). Information technology has developed rapidly, and the role of IT in education has changed over these years, from being an auxiliary to teaching to being an indispensable tool of education. Therefore, IT integrated instruction is distinguished from CAI.

In IT integrated instruction, information technology is an indispensable tool in the teaching environment because it is integrated into the curriculum, learning materials, teaching and learning [2]. Moreover, the traditional curriculum, materials, and teaching are transformed through the characteristics of information technology: the subject-based curriculum and materials become student-based; the teacher-driven teaching activities become student-centered. Information technology is integrated when it is used in a seamless manner to support and extend curriculum objectives and to engage students in meaningful learning. It is not something one does separately; it is part of the daily activities taking place in the classroom [3].

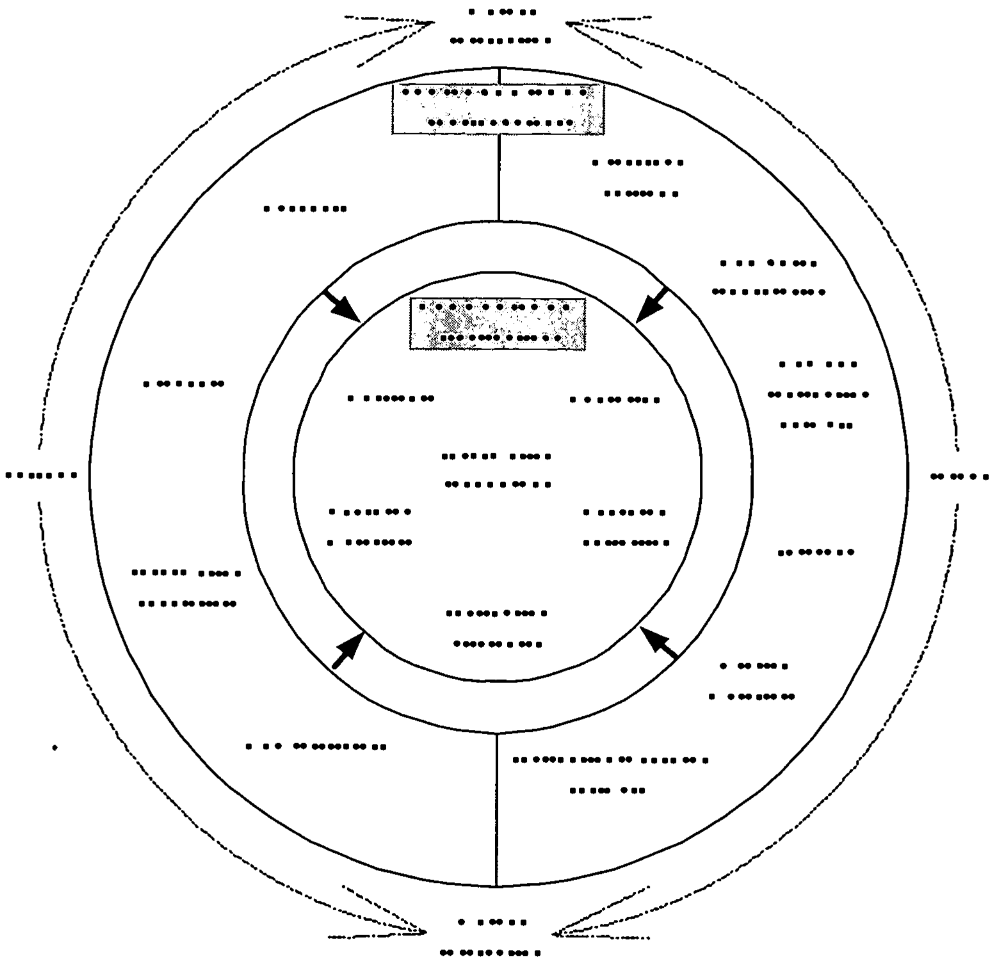


Figure 1. The assessment framework for information technology integrated instruction

Figure 1 depicts the assessment framework of IT integrated instruction. The assessment framework consists of two major parts: Kernel Part and Periphery Part. The kernel part primarily assesses the whole teaching process. Because the implementation of IT integrated instruction will bring about changes to teaching, the aspects to be assessed in this part should include not only the use of IT in teaching but also other perspectives of teaching: curricula, learning materials, instruction strategies, learning activities, and evaluation. The periphery part primarily assesses the teaching environment, learning resources, information equipment, personnel qualities, and administrative as well as professional support. All these factors will influence the outcome of teaching. In particular, IT integrated instruction is in need of supportive and coordinated environmental conditions. There are many perspectives of the periphery part that are related with IT integrated instruction, and ten of them are carefully identified and included for assessment: teachers, students, information specialists, administrators, classroom settings, computer laboratories, campus instruction network, Internet, digital materials, and instruction/learning software.

3 Assessing the kernel part

The kernel part refers to the whole teaching process, and Table 1 shows the perspectives and emphases to be assessed. The aspects of the kernel part are illustrated in the following paragraph.

Table 1. Emphases of the kernel part to be assessed

Perspective	Emphasis
Information technology	The use and role in instruction
Curricula	Subject-based separate curricula or Student-centered integrated curricula
Learning materials	Sequential or problem-based
Instructional strategies	Traditional expository approach or constructivist approach
Learning activities	Teacher-driven or student-centered
Evaluation	Traditional paper-and-pencil testing or multiple assessment

3.1 Information Technology

Information technology may refer to equipment or products, such as computers, network, peripherals, etc. It may also refer to the methods or processes in which the equipment of IT is used to help with the solution of problems. It is the purpose of implementing IT integrated instruction not only to enable students to use the equipment or products of IT but also to use the IT equipment to solve practical problems in learning and life.

In this perspective, we care about how IT is used in teaching and what role IT plays in teaching. The level of the use and role in instruction is developed:

- Nil (level 0)• IT is not used and plays no part in teaching.
- Isolation (level 1): IT is used to teach students how to use IT (e.g. keyboarding, drill-and-practice, word-processing activities). There is no or little connection between IT and instruction content.
- Supplement (level 2): Teachers use IT to assist instruction and students use IT to aid learning occasionally. IT is viewed as a supplement to existing instructional program.
- Support (level 3): IT is needed to complete most learning activities. IT serves as a support to instruction.
- Integration (level 4): Students and teachers can use IT in every-day learning/teaching naturally, confidently, and actively. IT is expansively viewed as tool, process, method to find solutions to authentic problems in any time anywhere.

3.2 Curricula

For elementary and junior high schools, the curricular idea should be life-centered and be in compatible with the development process of students' physical and mental abilities; respect character development, inspire individual potential; cultivate civic qualities, respect the value diversified culture system; enhance science knowledge and skill, meet the requirements of modern life. The design of curriculum should be based on students, on practical experience, and devoted to cultivating the basic abilities required of modern citizens [11]. Therefore, the curriculum should be designed as student-centered integrated or interdisciplinary curriculum, not subject-centered separate curriculum.

IT is used as a tool to help students solve the problem. IT literacy should not be taught as an isolated subject, nor should activities with IT be isolated from other activities in the classroom [12]. Therefore, Taking the students to the computer lab once a week for 40 minutes is not necessarily integration [3]. The teachers should commit to designing student-centered integrated curriculum and integrate IT into the curriculum.

3.3 Learning Materials

Textbooks are the main materials for elementary and junior high schools and the primary learning materials of students. In traditional education, textbooks were unified, having only one version. They were based on subject systems and separate from students' living experience. Besides, it was difficult to innovate them, they could not meet society' s requirements for rapid transformation. In 1996 Taiwan implemented a policy which would partially allow publishers to edit and provide textbooks for elementary and junior high school so long as they are approved by the Ministry of Education. On February 3, 1999, VIII (2) of National Education Act was empowered, which unequivocally directs the full use of ministry-approved textbooks for elementary and junior high schools. A new epoch for textbooks was thus heralded in. Teachers should be able to exert their professional autonomy, and students should be allowed a flexible, autonomous learning leeway.

The presentation of learning materials should not be limited to static traditional books, but the characteristics of computer multi-media should be used to present these materials. Static words and pictures, animated pictures and films, voice, acoustic effect and music in combination would make teaching materials lively and motivate students to learn. Besides, they can help students to understand abstract concepts or knowledge and enhance learning effectiveness. If hyperlink technology is used, nonlinear learning materials can be designed so that what students see can be highly individual and not the same. As such, the content of learning materials is flexible, adaptive to individual difference, and compatible with the spirit of individualized learning.

In addition to textbooks, there are many resources on the Internet that can be used as learning materials. These resources can provide "instant", "living" information [8]. Teachers not only can search for information to be included in teaching materials but also can use the real-time information on the Internet to conduct teaching. Students not only can search for information on the Internet but also can conduct independent learning any time, any place by using the learning materials on the Internet.

The use of information technology can make learning materials diversified and lively, make their content flexible and integrated with life. Not only can teachers easily motivate students to learn, but students also can learn happily in a rich teaching situation.

3.4 Instruction Strategies

The teaching strategy of the traditional expository approach is teacher-centered. Students learn what is taught by the teacher, but are given a limited room for thinking, discussion, presentation and exploration. The teaching effectiveness is ostensibly good, and students' performance on examination seems impressive. Yet this approach contradicts the essence of education. In a series of meaningless learning process, what students learn is segmented memory that is extraneous to their experience and cannot be applied in practical situations of their daily life. Nor can they enjoy learning.

Constructive teaching strategy is student-centered. The teacher would first arrange a teaching situation to arouse students' motivation for learning and then would conduce students to explore and think. Through the interaction with peers, the students can gradually integrate the new knowledge into their own system of knowledge and make it an essential part of this system. By this constructive teaching, students must actively learn, while the teacher can only play the role of facilitator, auxiliary, and consultant.

When students use teaching software and browse for Internet resources, they must explore and think actively and construct their own knowledge through the interaction between machine and person and through social interaction. Therefore, the teacher is a "coach" for the student rather than a provider of knowledge. Self-directed learning is an attainable goal for both the student and teacher when IT is integrated in the various content areas [6]. That is, IT integration is most likely to occur in learner-centered classrooms in which the teacher acts as a facilitator [3].

3.5 Learning Activities

Traditional lecture-based and teacher-driven activities can no longer satisfy the needs of modern education. It is not only monotone, also lacks interaction between peers. Learning activities should be student-centered so that the learner can actively work to explore knowledge, clarify concepts, and gradually construct his/her system of knowledge. In addition, project-based and cooperative learning activities should be adopted to allow the learner the opportunity to produce high-level interaction with his/her peers. These activities not only can cultivate a respectful, responsible, and confident attitude and the abilities to express, communicate, coordinate, think, and create but also can increase learning effectiveness.

In cooperative learning activities, students can use computer to communicate and discuss, or use a certain support cooperative work software to facilitate collaboration. Finally, multi-media would be used to present the learning effectiveness of students. Cooperative learning is not limited in local class. It can also be applied across schools, countries, and culture. Therefore, IT enriches the learning activity.

3.6 Evaluation

The traditional evaluation approach primarily depends on paper examinations and determines learning outcome by the scores on the test sheets. This type of evaluation measures only a dimension of knowledge, unable to reflect the wide spectrum of learning process. Future evaluation will become diversified; performance evaluation may be conducted along with paper evaluation; students' self-evaluation, peer evaluation and juried evaluation may be conducted along with teacher's evaluation; in addition to evaluating learning outcome, the learning process should be evaluated; in addition to quantitative evaluation, qualitative evaluation should be adopted; in addition to evaluating cognitive domain, the evaluation of affective and skill areas should be included. Only such a comprehensive evaluation can reflect the learning process, not only be able to understand what the student has learned but also be able to understand how the learning has occurred.

IT integrated instruction is helpful to the implementation of diversified evaluation. For example, the electronic portfolio is an ideal means of integrating IT into the instruction. It gives the student and teacher an alternative form of assessment. Furthermore, electronic portfolios motivate students to produce quality work, and they also increase students' self-esteem by showcasing their best work [6].

4 Assessing the periphery part

The periphery part primarily refers to the surrounding situations. Table 2 shows the perspectives and emphases to be assessed. The following illustration is based on perspectives.

4.1 Teachers

The teacher is vital in leading teaching activities. Without sufficient information literacy and professional ability, he or she cannot apply information technology on teaching, let alone implement IT integrated instruction. Regarding professional ability, the teacher should be able to integrate IT, in addition to assessing software and digital materials. The attitude is another emphasis of assessment. If the teacher has a positive attitude toward computer, he/she can readily introduce and apply computer on teaching; if the teacher can accept the change in teaching status and role, the implementation of IT integrated instruction would not cause a great impact.

4.2 Students

Students are the chief character in education. In teaching, students should take the initiative to construct their own knowledge. In implementing IT integrated instruction, students can obtain from the process related knowledge and skill and steadily strengthen their information disposition. Gradually students should be able to use, naturally and confidently, computer equipment in active learning and to construct their system of knowledge.

4.3 Information specialists

Teachers are not information specialists. In extensive application of IT to teaching, they will definitely encounter many technical problems that can not be solved by them. In this case, information specialists can support teachers in solving such problems. It is much easier for information specialists with education background to integrate IT with education and guide classroom teachers to implement IT integrated instruction.

4.4 Administrators

Whether administrators feel important about IT integrated instruction is intimately related with the implementation of IT integrated instruction. In addition, if the classroom teacher can gain sufficient administrative support, he or she will be more willing to implement IT integrated instruction.

4.5 Classroom Settings

Generally speaking, teaching activities are conducted indoors. Therefore, the IT equipment in classroom is indispensable to the integration of IT into teaching [14]. The computer and peripherals should not be outdated. The operation system and application software installed in the computer should be appropriate for the use by students and suit the needs of teaching. Moreover, for a class of more than 10 students, a large display device or broadcasting teaching equipment is needed. Finally, it matters whether they are managed properly or whether the fair use by students is ensured.

Table 2. Emphases of the periphery part to be assessed

Perspective	Emphasis
Teachers	Information literacy and professional competency Attitude toward information technology and instructional change
Students	Information literacy Attitude toward information technology
Information Specialists	Professional competency Support for teacher
Administrators	Attitude toward information technology integrated instruction Support for teacher
Classroom Settings	Number of computers and person-machine ratio Grades and fixtures of computer Operating system and application software. Peripherals (e.g. printer, scanner, digital camera) Broadcasting teaching facilities Management
Computer Laboratories	Number of computer labs, number of computers and person-machine ratio Grades and fixtures of computer Operating system and application software. Peripheral (e.g. printer, scanner, digital camera) Broadcasting teaching system Management
Campus Instruction Network	Structure of campus network and network type Domain account File server and database server CD cabinet (perhaps made possible through software simulation)
Internet	Method and speed of Internet connection Actual connection speed Internet server (e.g. web server, proxy server, DNS server, mail server) The mechanism to filter out inappropriate information.
Digital Materials	Digital materials that can be used on the Internet Digital materials created by the teacher
Instruction/Learning Software	Quantity Adaptation

4.6 Computer Laboratories

In a situation in which IT is integrated into teaching, sometimes it is required that one person have one machine. Computer laboratories can justly meet this requirement. Therefore, the management of computer laboratories is an important assessment item and can decide whether the computer equipment can sufficiently support classroom teachers [14]. Moreover, computer laboratories can also provide the most appropriate places for teachers' advancement and students' training of information skill. The equipment in the computer laboratories should not be outdated. Furthermore, there must be a broadcasting system, enabling students to know the whole content of teacher's lecture in a ready manner.

4.7 Campus Instruction Network

The planning and erection of campus instruction network aims not only to construct an instruction network on campus but also to enable every classroom on campus to connect to the Internet through the campus network. After the campus network is erected, File Server and CD cabinet (perhaps made possible through software simulation) should be erected, in which the teaching software owned by the school is stored so that all the teachers of the school can access to it readily and can apply it to teaching. In addition, the establishment and management of network account is equally important, ensuring the safety of information [14].

4.8 Internet

There are unlimited, un-exhaustive teaching resources on the Internet. If computers can not be connected to the Internet, the application of IT to teaching is compromised. Therefore, it is very important to provide information settings of the Internet. In addition, it is needed to erect Internet-related Server, in particular, Web Server must be erected so that teachers' teaching information and the learning outcome of students can be stored on it to facilitate examination and simulation by teachers and students. Besides, Internet is full of erotic and violent information which is unsuitable to students. It is extremely important to build a mechanism to prevent students from seeing those inappropriate content [14].

4.9 Digital Materials

Digital materials may be presented through information equipment and be used in teaching activities. Therefore, plentiful digital materials should be able to help integrate IT into teaching of various subjects. Therefore many on-line materials on the Internet can be used for teaching purpose. To decrease the amount of time required for browsing and facilitate the use of the materials by teachers and students, on-line index and search systems are also required. In addition, if on-line materials are not appropriate for teaching needs, classroom teachers may create their own materials to be presented on information equipment or use materials created by colleague teachers with the approval from the original designer [14].

4.10 Instruction/Learning Software

Computer Assisted Instruction (CAI) and Computer Assisted Learning (CAL) software is a help to teaching and learning. With more software, teachers are better equipped to apply IT to teaching. This software should be stored on the CD cabinet or File server on the campus network so that teachers can readily use it whenever needed. In addition, if existing teaching software available on campus is evaluated, further information can be provided to teachers [14].

5 Conclusions

That teachers and students can extensively use computers for teaching or learning purpose to heighten teaching qualities and learning effectiveness is the ultimate goal of the infrastructure construction of information education [5]. In other words, integrating computer into teaching of various subjects is the ultimate goal of the Ministry of Education in promoting information teaching [13]. What IT integrated instruction means is not merely to assist teaching by computer but work to integrate IT into curriculum, learning material and learning activities. At this point, the role of teachers begins to transform, from that of a main character to that of a support character. Therefore, the implementation of IT integrated instruction not only harmonizes with the u ltimate goal of information education but also prompt the reform of education so that learning becomes more effective, efficient, and meaningful.

IT cannot be successfully integrated overnight. It needs to take years to complete the process. The process should be carried out in order, stage by stage. Taiwan's IT integrated instruction is germinating. The assessment framework set forth in this article can be used not only to carry out practical evaluation but also serve as reference for development. Teachers' in-service education, pre-service training, administrative support, enriching IT equipment, developing appropriate digital materials and teaching software should be taken to strengthen the perspectives of the periphery part and to diversify the surroundings so that teachers can realize the benefits brought about by IT on education, Accordingly, teachers can apply IT to teaching, gradually infuse IT into learning activities, curricula, learning materials, and adopt student-centered teaching strategies and multi-facet evaluation. All this can lead to the fulfillment of the meanings of IT integrated instruction.

References

[1] Chang, H. Y., "1999 review of implementation of infrastructure construction plan for information education by the Ministry of Education", Ministry of Education Computer Center newsletter, No. 8810, pp. 1-8, (1999).

[2] Chiu, K. H., "Concepts and methods of computer-integrated instruction", Taiwan Education Review, No. 479, pp. 1-8, (1990).

[3] Dias, L. B., " Integrating technology: Some things you should know", Learning & Leading with Technology, Vol. 27, No. 3, pp. 10-13, 21, (1999)

[4] Dexter, S. L., Anderson, R. E., & Becker, H. J., "Teachers' views of computers as catalysts for changes in their teaching practice", "Journal of Research on Computing in Education", Vol. 31, No. 3, pp. 221-239, (1999).

[5] Han, S. M., "Infrastructure construction of information education – acceleration", Information and Education, No. 68, pp. 14-16, (1998).

[6] Hanfland, P., "Electronic portfolios: Students documenting their best work", Learning & Leading with Technology, Vol. 26, No. 6, pp. 54-57, (1999).

[7] Her, J. K., "Viewing the prospects of information education in elementary and junior high schools from the promoting strategy of information education of the Ministry of Education", Information and Education, No. 68, pp. 2-13, (1988).

[8] Lee, C. M., Wu, C. J., & Lin, M. C., "Erection of information education software and material resources center", Information and Education, No. 68, pp. 21-28, (1998).

[9] Levine, J., "Planning strategically for technology integration", Proceedings of Technology and Teacher Education Annual 1998 (SITE '98), Charlottesville, VA, pp. 293-295, (1998).

[10] Mehlinger, H., "School reform in the information age", Phi Delta Kappan, No. 77, pp. 400-407, (1996).

[11] Ministry of Education, "Tentative Guideline for Nine-year Integrated Curriculum for Elementary and Junior High Schools (first learning stage)", http://teach.eje.edu.tw (accessed on April 13, 2000).

[12] Sprague, D. & Dede, C., "If I teach this way, am I doing my job: Constructivism in the classroom", Learning & Leading with Technology, Vol. 27, No. 1, pp. 6-9, 16-17, (1999).

[13] Tu, A. P. & Lin, H. H., "Accelerating the infrastructure construction of Taiwan's information education: Alternative for expanding internal demand – special interview of Chen Li-hsiang, director of computer center of the Ministry of Education", Information and Education, No. 68, pp. 29-32, (1998).

[14] Wang, C. S., "Criteria for assessing information situation of information technology integrated instruction", Information and Education, No. 77, pp. 36-47, (2000).

Analyses of Cognitive Effects of Collaborative Learning Processes on Students' Computer Programming

Jun MORIYAMA
Department of Information and Technology Education,
Faculty of Education, Shinshu University
6 Nishinagano, Nagano City, Nagano, 380-8544, JAPAN
Phone: +81-26-238-4175
Facsimile: +81-26-232-5144
E-mail: junmori@gipwc.shinshu-u.ac.jp

The purpose of this study was to clarify the cognitive effects of collaborative learning on Junior high school students' Logo programming. Two experiments were implemented: *Experiment1* was an analysis of the relationships between interaction in pair activities and students' reflection. The effects of pair learning on students' promoting abilities of programming were analyzed in *Experiment2*. As the results of *Experiment1*, students' self-monitoring and self-control were supplemented each other through the interaction. Results of *Experiment2* suggested that the effect of collaborative learning on students' programming abilities were developments of debugging ability against syntax error and coding ability of lower students, which was obtained the cognitive strategies for task division through the interaction.

Keywords: **Collaborative Learning, Junior High School Students, Cognitive Effects, Logo Programming**

1 Introduction

In Japan, education about computer programming was placed in *Fundamentals of Information* of *Industrial Arts* at junior high school level from 1989. From 2002, programming, sensing and control will be placed in *Information and Computer* of *Technology* as an elective learning content (*Course of Study* published in 1998)[5]. Many technology teachers in Japan thought that teaching programming was not only for professional higher education. They didn't made points of understanding the function of software upon a computer system, but acquiring the problem solving skills through the programming activities.

Historically, many researchers suggested that one of the methods for acquiring the problem solving skills was collaborative learning. It was necessary for students to communicate and interact with someone who had same goal in collaborative environment (Deutsch 1949)[1]. In the recent past, it was supported that the experiences of solving the problem through the interaction made the processes of planning and decision making clearly each other, and would promote their self-control and self-monitoring when they would solve another problem all by themselves (SATOU 1996)[3]. In the case of learning about programming, KAGE (1997) suggested that 12-year old pupils showed vigorous verbal interaction, which led them to more sophisticated problem solving [4].

From these findings, it was predicted that acquiring the problem solving skills brought to promote students' programming abilities as a result of cognitive effects of collaboration.

The purpose of this study was to clarify the cognitive effects of collaborative learning on students' programming. For this purpose, two experiments by using Logo programming (Japanese Edition) were implemented. The aim of *Experiment1* was to clarify the relationships between interaction of collaborative learning processes and learners' reflection. The effects of collaborative learning on students' promoting abilities of programming were analyzed in *Experiment2*.

2 Methods

2.1 Experiment1

2.1.1 Subjects

Twelve 3rd grader Jr. high school students (6 males and 6 females) were divided into 6 pairs.

2.1.2 Instruments

"The Reflection Scale of Thinking Process on Computer Programming: RSTC"(MORIYAMA et al 1996) [2] and the modified LUTE (Link-UniT-Element) model (MORIMOTO et al 1997) [6] were used for measuring the level of reflection and analyzing the interaction, respectively. The RSTC was constructed from 4 factors as in Fig.1. Factor1 was the reflection of understanding the problems and enterprising how to make the program adequately. Factor2 was the reflection of designing the program and coding. Factor3 was the reflection of self-monitoring on each parts of the program on the local level. Factor4 was the reflection of self-monitoring on the whole program and renewal of problem representation.

Factor1 (6 items)	Factor2 (6 items)	Factor3 (5 items)	Factor4 (3 items)
Semantic understanding of the problem	Setting up the keywords	Predicting the result of running	Analyzing the bug
Imaging the command and grammar	Division of the program	Testing walk through the list	Renewal of problem representation
Comprehending the image of program	Setting up the functional unit	Checking the clerical error	Seeking the bug
Rhetorical understanding of the program	Connecting the functional unit	Checking the syntax error	
Seeking the semantically-related knowledge	Coding the functional unit	Checking the logical error	
Seeking the rhetorically-related skill	Checking the sequences of each commands		

Fig.1 The Reflection Scale of Thinking Process on Computer Programming: RSTC

The modified LUTE model was shown in Fig.2. There were categories for analyzing interaction of collaborative learning in this model, and this model had three abstract levels: element, unit and link level. The items of element level were categories for functions of protocols. The unit and link level categories were for phases and contexts in their programming activities.

Element Level (5 categories)	Unit Level (6 categories)	Link Level (6 categories)
Proposed	Phase of Analysis	Link for Formation of plan
Agreement	Phase of Plan	Link for Modification of plan
Question	Phase of operation	Link for Implementation of plan
Opposition	Phase of Edit	Link for Check of Implementation
Supplementary explanation	Phase of Checking the program list	Link for renewal of plan
	Phase of Checking the result of running	Link for renewal of implementation

Fig.2 The modified LUTE (Link-UniT-Element) model

2.1.3 Procedures

Subjects were asked to make the Logo program which draw the "*House*" constructed from triangular shapes, square patterns, circles and lines in pair. Their activities were recorded on a VTR. After they finished the task, they answered RSTC individually. Their protocols were extracted from the VTR and were categorized by using modified LUTE model. The level of reflection and the relative interaction in the collaborating pair were analyzed by ANOVA on mean scores of frequencies of link level categories and Coefficient of Correlation (r) between the RSTC scores and frequencies of the element and unit level categories.

2.2 Experiment2

2.2.1 Subjects

Sixty 3rd grader junior high school students (30 males and 30 females) were divided into 2 groups learning Logo programming. One was collaborative learning group (pair), and the other was individually learning group.

2.2.2 Instruments

The achievement tests and the RSTC were prepared. The achievement tests included both the coding test and the debug test. The coding test asked to make a program drawing "*Scarecrow*" on an answer sheet. The debug test asked to find three types of error, clerical error, syntax error, logical error from the program list which drew "*Spaceship*".

2.2.3 Procedures

The procedure was shown in Fig.3. At first, subjects had a coding test which draws the easy "*flag*" as a pre-test. Next, subjects were asked to make the program, which draws the "*House*" such as *Experiment1* and answered RSTC in every group as a middle-test. Finally, they had the achievement tests and answered RSTC individually as post-tests. The effects of collaborative learning on students' promoting abilities of programming were analyzed by using ANOVA and Coefficient of Correlation (*r*) between the RSTC scores and the Achievement tests' scores.

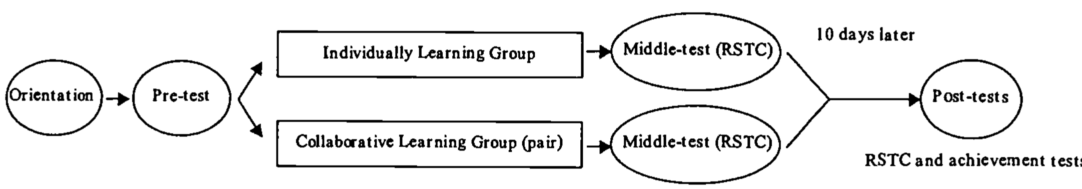


Fig.3 The procedure of *Experiment2*

3 Results and Discussion

3.1 Experiment1: Students' Reflections and Collaborative Programming

3.1.1 Contexts of Collaboration in the Pair Activities

There were differences of period of keyboard operation time in pair activities. In this analysis, long-operated learners were called *Learner A*, and the others (short-operated) were called *Learner B*. Mean scores of frequencies of link level categories were shown in Table.1.

Table.1 Frequencies of link level categories

Link Level Categories	Mean Score (S.D.)				ANOVA
	Learner A to B	*Learner B to A*	*Learner A to A*	*Learner B to B*	
Link for Formation of plan	1.75 (1.04)	2.00(1.77)	1.63(1.41)	3.50(2.73)	*n.s.*
Link for Modification of plan	3.35(2.12)	2.50(1.93)	0.25(0.46)	0.13(0.35)	F(3,24)=8.397, p<.01
Link for Implementation of plan	1.88(2.70)	15.63(5.80)	5.88(3.40)	2.75(2.49)	F(3,24)=21.732, p<.01
Link for Check of Implementation	3.75(1.49)	1.13(1.36)	1.00(1.07)	0.13(0.35)	F(3,24)=13.055, p<.01
Link for renewal of plan	0.38(0.52)	0.38(0.74)	0.13(0.35)	0.63(0.52)	*n.s.*
Link for renewal of implementation	0.63(0.92)	1.25(1.28)	0.25(0.46)	0.00(0.00)	*n.s.*

Results from Two-way Repeated Measures ANOVA showed that there were significant main effects of Links for Implementation of Plan from *Learner B.* to *A* [F(3,24)=21.732, p<.01], and Links for Check of

Implementation from *A* to *B* [F(3,24)=13.055, p<.01]. Also, Links for Modification of Plan with interaction (*B* to *A* and *A* to *B*) were increased than that of individually links (*A* to *A* and *B* to *B*) [F(3,24)=8.397, p<.01]. These data indicated that the role of operation (*Learner A*) and the role of planning (*Learner B*) were shared in pair activities. However, it was suggested that consensus decision making through the interaction was important for building up their programming plans.

3.1.2 The Relationships between the Interactions and the Reflections

Coefficient of Correlation (*r*) between the RSTC scores and frequencies of element level categories were shown in Table.2. According to these data, when *Learner A* (operator) proposed something to operate, the reflection of designing the program (Factor2) was promoted in own thinking process [*r*=0.88, p<.01]. However, when *Learner B* (planner) proposed, the reflection of self-monitoring on each parts of the program (Factor3) was promoted in *Learner A*'s thinking process[*r*=0.88, p<.01]. Furthermore, opposition by *Learner A* correlated the reflection of self-monitoring (Factor3) in *Learner B*'s[*r*=0.71, p<.05]. Also, *Learner A*'s reflection of designing (Factor2) was promoted by the opposition of *Learner B*[*r*=0.77, p<.05]. These results indicated that the verbal communications on their interaction brought out their self-monitoring and self-control each other.

Table.2 Coefficient of Correlation (*r*) between the RSTC scores and frequencies of element level categories

Element Level Categories		Factor1		Factor2		Factor3		Factor4	
		Learner A	*Learner B*	*Learner A*	*Learner B*	*Learner A*	*Learner B*	*Learner A*	*Learner B*
Proposed	*Learner A*	0.41	0.26	0.88**	0.41	0.52	0.13	0.06	0.06
	Learner B	0.04	0.45	0.37	0.25	0.88**	-0.33	0.50	0.31
Agreement	*Learner A*	0.00	-0.10	0.31	-0.34	0.52	-0.66	0.26	-0.20
	Learner B	0.44	0.35	0.67	0.55	0.28	0.08	0.36	0.07
Question	*Learner A*	-0.32	0.56	0.27	0.28	0.56	-0.11	0.78*	0.23
	Learner B	0.40	-0.52	0.56	-0.29	0.00	0.02	0.03	-0.31
Opposition	*Learner A*	0.03	-0.30	0.27	0.08	0.13	0.71*	0.42	0.19
	Learner B	0.12	0.19	0.77*	0.23	0.52	0.27	0.68	0.00
Supplementary explanation	*Learner A*	0.72*	-0.35	0.61	0.13	0.03	0.40	-0.15	-0.01
	Learner B	-0.01	-0.34	0.32	-0.13	0.14	0.40	0.45	0.08

n=8, df=6, **p<.01, *p<.05

In addition, Coefficient of Correlation (*r*) between the RSTC scores and frequencies of unit level categories showed that, operation by *Learner B* as a planner conduced to *Learner A*'s self-monitoring on whole program[*r*=0.85, p<.01]. Also, task analysis by *Learner A* as an operator encouraged *Learner B*'s designing of the program[*r*=0.75, p<.05]. It was evident that one's reflective thinking was precipitated by the observation of the other's behavior which was supposed to be his own behavior.

These results of *Experiment1* suggested that students' meta-cognition (self-monitoring and self-control) were supplemented each other through the interaction of collaborative pair learning.

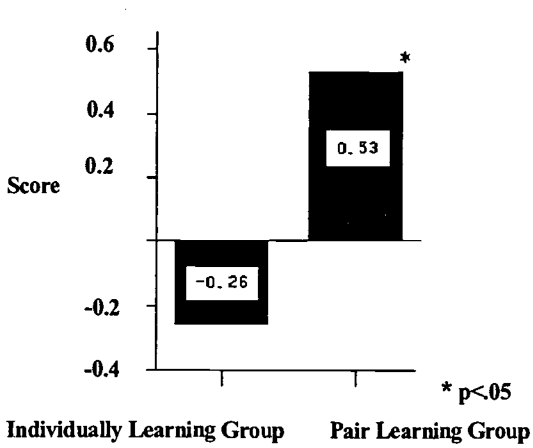
3.2 Experiment2: Effects on students' promoting abilities of programming

3.2.1 Acquisitions of Programming Abilities

In the pre-test, there are not significant differences between the pair learning group and the individually learning group [F(1,56)=0.65, *n.s.*]. Students who could get high scores were called *higher students* and the others were called *lower students* in this analysis (both 50% and n=30). In the middle-test, mean score of RSTC in the pair learning group (0.77) was higher than that in the individually learning group (0.56) [F(1,56)=32.40, p<.01]. This result supported findings of *Experiment1* because collaborative pair learning could promote students' reflections of thinking processes.

Mean scores of debug test were shown in Fig.4. Results from the ANOVA showed that the debugging scores of syntax error in the pair learning group was higher than that in the individually learning group [F(1,56)=4.75, p<.05]. But, there were not significant differences on the debugging scores of clerical and logical errors [F(1,56)=2.06 and F(1,56)=0.89, both *n.s.*]. These results indicated that collaborative pair learning could form students' debugging abilities against syntax errors, at least.

Mean scores of coding test were shown in Fig.5. The result from the Two-way Repeated Measures of ANOVA showed that there was significant interaction between *High-Low student* condition and *pair-individually* group condition [F(1,56)=10.46, p<.01]. Furthermore, from the results of Simple Main Effects Tests, the score of *lower students* in the pair learning group was promoted to the same level as *higher students* in both groups [F(1,56)=12.56, p<.01]. These results indicated that the coding abilities of Low-Ability students could be pulled up through the interaction with High-Ability students.



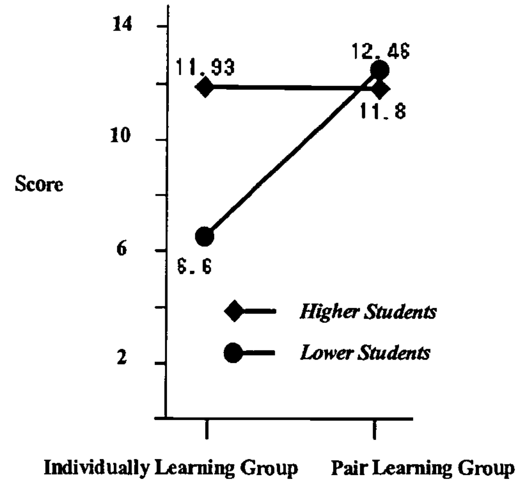


Fig.4 Mean scores of debug test (syntax error)

3.2.2 Acquisitions of Cognitive Strategies

Coefficient of Correlation (*r*) between the RSTC scores and the achievement tests were shown in Table3. According to these data, there were significant correlation between the coding test and the RSTC items: "Division of the program"(*r*=0.31, p<.05), "Coding the functional unit"(*r*=0.41, p<.01), "Connecting the functional units"(*r*=0.40, p<.01) and "Selecting the commands for each functional units"(*r*=0.40, p<.01) . Also, There were significant correlation between the debug test and the RSTC items: "Division of the program"(*r*=0.29, p<.05), "Checking the sequences of each commands"(*r*=0.33, p<.01). It was indicated that promoting these reflections were responsible for the development of the programming abilities. Furthermore, these items suggested the reflections of cognitive strategies for task division.

Table 3 Coefficient of Correlation (*r*) between the RSTC scores and the achievement tests

Items of RSTC	Achievement Tests			
	Coding Test		Debug Test	
Division of the program	0.31	*	0.29	*
Coding the functional unit	0.41	**		
Connecting the functional units	0.40	**		
Selecting the commands for each functional units	0.40	**		
Checking the sequences of each commands			0.33	**

**p<.01, *p<.05

Results of *Experiment2* suggested that the effect of collaborative learning on students' programming abilities were developments of debugging ability against syntax error and coding ability of lower students, which was obtained the cognitive strategies for task division through the interaction.

4 Conclusion

In this study, it was clarified that students' meta-cognition and cognitive strategies could be acquired through the collaborative learning at junior high school level, also that the RSTC was useful for measuring students' reflections in their programming activities. These findings will contribute to the researches of developments of collaborative learning systems.

For the future, learning processes and cognitive effects of more widely collaborative learning environment, for example, distributed programming by using CSCL system or long distance education for programming by using Internet, must be analyzed.

References

[1] Deutsch, M, An experimental study of the effects of cooperation and competition upon group process, *Human Relation*, 2: pp.199-232, (1949)

[2] Jun MORIYAMA et al, Structural Analysis of Thinking Processes on Students' Computer Programming, *Journal of Japanese Society of Technology Education*, 38-4: pp.255-262, (1996) (In Japanese)

[3] Kouji SATOU, Motivation for Learning and social context, *Cognitive Science 5: Learning and Development*, Tokyo University Press: pp.221-247, (1996) (In Japanese)

[4] Masaharu KAGE et al, Effects of Media and Learner Collaboration on Programming Education in Children, *Japan Journal of Educational Technology* 21-2: pp.93-105, (1997) (In Japanese)

[5] Ministry of Education, Science, Sports and Culture, Government of Japan, *Course of study for lower secondary schools in Japan,*(1989) (In Japanese)

[6] Shiro MORIMOTO et al, An analysis of Collaborative Discovery Learning Processes Based on Hierarchical Schema, *Cognitive Science* 4-2: pp.3-17, (1997) (In Japanese)

Note:

This study was revised and enlarged version of the following papers published in Japan:

Jun MORIYAMA, An Analysis of Collaborative Learning Process on Students' Computer Programming, *Journal of Japanese Society of Technology Education*, 41-4: pp.187-196, (1999) (In Japanese)

Jun MORIYAMA et al, Development of the students' abilities for Computer Programming through the Collaborative Learning, *Proceedings of the 42nd Annual Conference of Japanese Society of Technology Education*: p.21, (1999) (In Japanese)

Applied the Gray Relationship Matrix and Learning Obstacles Analysis on the Discovery Teaching

Chao-Fu Hong, En-Yih Jean, Pei-Chin Wu, Chien-Miing Lia and Tsai-Hsia Wu*
**Aletheia University, Nei-Li High School*
cfhong@email.au.edu.tw
No. 32 Chen-Li Str. Tamsui City Taiwan ROC
TEL:886-2-26212121-5536

At recently year the research of teaching method are trending to request the student for active learning, to avoid the student to learn the stuff knowledge. Therefore the number of researchers in the constructivism and cooperative learning etc fields are many. Even now how to estimate the student's learning attitude belong an active type, is a big problem. In our research, we recur to the simple method, adopt the discovery teaching. Because under the discovery teaching, the student does not only use his ground knowledge, but also need face the problem's stimulation and bring the solution. This method can mostly saturate the today's teaching trend. But how to analyze the student's learning obstacle area and supply the explanation to help him cross over the learning barrier is a net bottle in the discovery teaching. In this paper, connect the concept graph and the gray decision-making to issue the gray analyzing method of learning obstacle. This method has a flexible ability to point out the area of learning obstacle, it also can infer the student inbuilt concept or relationship on his knowledge structure. Finally, according to the expert's experiments rule to clearly distinguish the core of problem. Then the system obeys the inferring rules to bring the explanation and the similar question to stimulate the student to build his whole knowledge. This learning cycle will continue until the student completely finishes his learning.

Keywords: **Discovery Teaching• Gray Theory• Concept Graph• OO**

1 gray relational concept graph

a. The design of cognitive structure

Induct the student to learn the material, not only implant him a located knowledge, but also hope he can actively learn or construct the knowledge. Therefore, our system want to stimulate the student, and hope he use his langue or letter to descript his thinking. It like he uses his symbols to review the content and build his cognitive structure. Therefore in our system, our chapter designing does not like traditional, we use the proposition to build concept graph.

Table 1 the relationship matrix

relation / node	Node 1	Node 2	Node 3	Node 4	Node 5
Node 1					
Node 2					
Node 3					
Node 4					
Node 5					

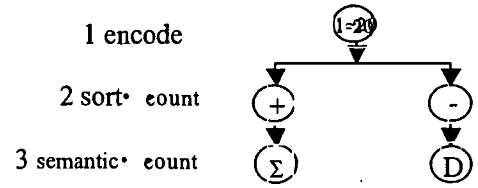


Fig. 1 Concept Garph

b. Relational concept graph

From the cognitive structure graph we can understand that the relation be assembled by node linking to other node, of course each relation also has its particular mean. And in our system the question is based on proposition, then accord with the problem' s subject the expert can distribute the weight to each node and each relation. These data can be consisted a matrix, and we call this matrix as the conceptual relationship matrix.

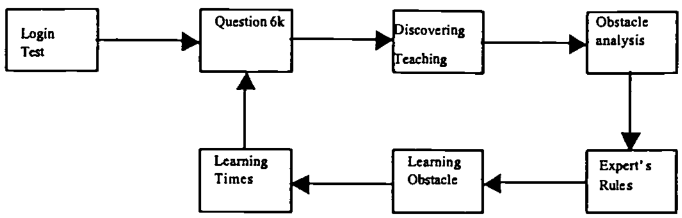


Fig. 2 System graph

As Fig.2, when the student log into the system, the system will give him some questions are selected from the question database. After the student transmit his answers to system, the system will start to analyze his learning obstacles. Of course, the student' s does not have much time for studying, the system hardly collect the enough data for analyzing by statistical recursive method. Because the statistical recursive has some limited: large data, the data distribution must like normal and the variants cannot too many. Consequently, the only way we can elect to adopt the gray theory to reduce the analyzing data. This matrix is called the gray relational conceptual matrix.

2 Gray relational learning obstacles analysis

The gray decision making system is meaning that the system includes some gray element (uncertainty or incomplete factor). In general case, the decision making space X is constituted by event sets S• {Sij} and efficiency sets R..

After the student interact with system, the system can collect his data to assemble the gray relationship' s matrix. The analysis method explains as following.

Table 2 the relationship matrix

relation / node	Node 1	Node 2	Node 3	Node 4	Node 5
Node 1	0	0	0	0	0
Node 2	0	0	0	0	0
Node 3	0	0	0	0	0
Node 4	0	0	0	0.5	0.5
Node 5	0	0	0	0.2	0.8

Table 3 the gray relationship' s matrix

relation node	Node 1	Node 2	Node 3	Node 4	Node 5
Node 1	0	0	0	0	0
Node 2	0	0	0	0	0
Node 3	0	0	0	0	0
Node 4	0	0	0	1	1
Node 5	0	0	0	0.2/0.8	1

1. According to the Grey formulate, can translate table 2 to table 3. The system can calculate each node' s average weight, and according these values to arrange their ranking.

Table 4

Node 1	Node 2	Node 3	Node 4	Node 5
0	0	0	1.25/2	2/2

2. If the nodes weight higher than the threshold value 0.3, the system can find the weight at node 4 and 5 are higher than 0.3, the system define these nodes are the learning obstacle nodes.
3. At the same time, according to the relation' s matrix (table 2), the relation 4-5 is 1 higher than • •cut (0.3) is the relation of learning obstacle.
4. According to the expert' s rules decide expanding or reducing the learning obstacle area.
   Use the aforementioned logic the system can reduce the relation 5-4 and relation 4-5 to infer the learning obstacle area is node 5

3 Conclusion

On the teaching the most afraid thing is to induct him learning the inert knowledge. Therefore, in all teachings methods the discovery teaching is the only one can avoid this problem that is why we adopt the discovery teaching to develop our system. But how to break through the discovery teaching' s net bottle, our issue are: integrate the concept graph and gray decision-making system to develop the gray analyzing method, and use it to discover the student' s learning obstacle. This analyzing has an ability to point out the learning obstacle area, and enhance the inferring ability to find the student' s learning obstacles or the incompletely knowledge, then pass through the expert' s rules, the crossing analysis method can find the problem kernel. Then system rely on this result to elect the problem saving content, let the student can learn it again and rebuild his knowledge structure until he can construct the whole knowledge.

Reference

[1] Chao-Fu Hong• Yueh-Mei Chen*• Yi-Chung Liu• Tsai-Hsia Wu :Discuss 3D cognitive graph and meaningful learning,ICCE99.

Collaboration and communication: staff development for teaching and learning online

Linda Creanor* and Dr. Allison Littlejohn**
**Department of Learning and Educational Development, Glasgow Caledonian University, St Andrew House, 141 West Nile Street, Glasgow G1 2RN, Scotland, UK email: l.creanor@gcal.ac.uk*
***Centre for Academic Practice, University of Strathclyde, Graham Hills Building, 40 George Street, Glasgow G1 1QE, Scotland, UK*
*email: **allison.littlejohn@strath.ac.uk***

Recent advances in internet communications technologies offer great potential for university teachers wishing to enhance teaching and learning by incorporating dialogue. Since many university teachers are as yet unfamiliar with the pedagogical and practical skills required to implement these technologies in their teaching it is essential that they are supported by a coherent and comprehensive staff development programme allowing them to develop the required skills. This paper describes a collaborative programme offering support to university teachers wishing to implement dialogue through communications technologies. It offers an analysis of the impact of this programme in changing the teaching strategies of academic staff. The results of this study highlight several universal factors affecting the take-up of internet communication technologies for teaching and learning. This study will be of interest to staff developers planning to implement similar programmes within their own institutions.

Keywords: **staff development, internet communication, collaboration**

1 Introduction

In order to meet the needs of an increasingly diverse learner profile, universities worldwide are gradually shifting towards more flexible course provision. Advances in information and communication technologies (ICT) are being harnessed to support teaching and learning and to maintain the vital communication links between tutors and students both on- and off-campus. University teachers are being asked to rethink the teaching methods with which they are familiar [1] and to acquire the skills necessary to develop, manage and facilitate online courses with students whom they may meet only in a virtual environment [2, 3]. Thoughtful preparation is required for this demanding shift in teaching methodology and many universities are investigating how this can be supported.

In 1997, two universities in the West of Scotland were in the process of creating a new support framework for academic staff to encourage a greater acceptance of ICT as an addition to the teaching toolkit. Contact between the departments responsible for staff development in Glasgow Caledonian University and the University of Strathclyde had already been established through personal links, and as the two institutions were geographically close within the City of Glasgow, it was decided to capitalise on these links through collaboration.

One obvious area which is crucial to an effective online learning experience is that of communication. Dialogue is key to the development of a deep understanding and must be supported, either through a direct tutor/student conversational framework as described by Laurillard [4] or by learning vicariously from peers through asynchronous communication as advocated by Mayes [5]. Therefore the initial focus of attention was the implementation of dialogue. As workshop tutors we worked together to create an event which would not only raise awareness of internet communication tools, but also emphasise the pedagogical implications of new technology and provide participants with the opportunity to experience online communication in its various forms. Tools used ranged from text-based bulletin boards and synchronous chat to desktop and full bandwidth videoconferencing. Participants were asked not only to learn to use the tools, but to move beyond the basic skills level to using them to learn as described by Voss [6] through discussing and debating real learning and teaching issues with their colleagues at the neighbouring institution.

The intention was to create a realistic scenario where internet communication was actually being used between two geographically separated sites and where academic staff would have the opportunity to experience this form of communication from both tutor and student perspectives. Through a combination of hands-on experience of the tools, discussion and presentations of case studies, participants were encouraged to reflect on the potential of these technologies for their own teaching, whilst gaining some insight into the student experience.

Evaluation data collected at the end of each workshop revealed a very positive response to this form of staff development with 75% of participants stating that they found the course "good, very good or excellent". However, since the aim of the workshop was to raise awareness of the potential offered by new technologies and help promote a change in teaching methods within these two institutions, further evaluation studies were necessary to ascertain what impact, if any, this form of staff development had made on teaching and learning in both institutions.

2 Analysis of staff responses

A more detailed online evaluation was carried out in November 1999. Out of a total of 104 participants working in academic and related posts (52 from Strathclyde and 54 from GCU) 68 were still employed by the two institutions. This was mainly due to the fact that many staff had been hired on short-term contracts of typically one to two years, so a number of them had subsequently taken up employment in other universities. 29% of the remaining staff responded to an online survey which was carried out using the Clyde Virtual University evaluation wizard (http://cvu.strath.ac.uk). While this low response rate cannot be fully representative, it nevertheless offers a revealing insight into the effects of this form of staff development.

While only 25% of respondents had implemented internet communication in their teaching, almost all respondents stated they were "planning or possibly planning" to implement technology based teaching in the near future. Subsequent responses revealed that the reason for this could be due to the fact that many of the course participants were academic related staff and did not yet have a teaching role. As one respondent stated,

"When I took part in the earlier communications workshop I was a contract researcher and had little in the way of teaching responsibilities. However, I have recently been appointed as a lecturer ... and would hope to be developing more in the way of on-line materials."

Perhaps the workshops presently fulfil the aim of "awareness raising" and the full impact in terms of "promoting changes in teaching methods within these two institutions" will take several years to filter through.

When questioned about the type of internet communication techniques implemented, text based discussions were most commonly used, followed by file transfer and videoconferencing. The main uses of these technologies were to "communicate remotely with students" and to encourage student interaction. This indicates not only a change in the medium for teaching but also a progression away from the didactic, information giving, lecture style of teaching to a more "constructivist" approach. This is in agreement with the thinking of Laurillard [4] who views lectures as 'a grossly inefficient way of engaging with academic knowledge' and of Mayes [7] who argues the importance of dialogue as an essential ingredient for learning, since it enables construction, discussion and reflection on concepts. Despite this there was a mixed response to whether or not the use of communications technologies actually enhanced particular teaching and learning situations. One respondent stated:

"Using the internet, while initially appealing, seems to be more trouble than it's worth. Many of the students do not like the lack of personal interaction"

While another concluded that the internet afforded students, *"an opportunity to share information more widely"*.

It seems that, although participants leave the workshops enthused about internet communication, there is a lack of momentum which they feel should come from departmental strategy. Of those respondents who stated they had not implemented internet communications technologies in their teaching the main barriers focussed around issues of time to implement new teaching strategies and a perceived lack of technical expertise. For example 40% of respondents indicated that they feel they have insufficient time to implement internet communication, 35% intimated a need for improved technical support, 20% stated their students required more IT training and 20% felt that improved university facilities were required. These results are in agreement with other studies [8, 9].

When asked to comment on the statement "These learning technology workshops are effective in changing teaching and learning within the University", out of 16 responses to this question 8 agreed, 4 were neutral and 4 disagreed. Overall therefore, there was a positive response to this form of staff development. There was also a leaning towards subject based training, though accredited training, encouraged by recent government legislation in the UK [10] was not strongly favoured.

3 Summary of Results

The results of this study have revealed that:

- This form of staff development is highly effective in raising awareness of the potential of internet communications technologies;
- The full impact of this form of staff development in terms of changing teaching methods may not be realised for some time due to the fact that not all participants had a teaching role;
- Of those who had used internet communication there was a mixed response to whether or not it actually enhanced their teaching;
- Lack of time and technical expertise and student inexperience with technologies were listed as the main barriers preventing effective use of internet communication for teaching and learning;
- There was general agreement that this form of staff development is effective, though responses reveal a necessity for the implementation of teaching, learning and assessment strategies.

It is interesting to note that the effectiveness of the collaboration between the two institutions is less apparent, as although 50% found it enhanced the experience, 26% disagreed. This was a disappointing result, as it had been anticipated that sharing the learning experience would have featured more positively in the evaluation feedback. In contrast, all the tutors agreed that the synergy created in developing and presenting this joint event was extremely valuable, and indeed has led to further sharing of resources and expertise in cross institutional staff development provision.

Glasgow Caledonian and Strathclyde universities are two very different institutions, as the latter is a long established university and the former has only in recent years attained university status. Nevertheless respondents from both institutions have clearly expressed their need for a more strategic approach by university management. Comments included,

"I do think the University needs to think very carefully about policy and funding, and to ensure that the appropriate back-up services are there." (Strathclyde)

"The University needs to be explicit in its support for the use of technology in all that we do and to actively state that this is the 'expected' way forward -i.e. provide a clear vision." (GCU)

Clearly, a cohesive, structured, top-down approach is needed to complement the developments at departmental and faculty level in order to encourage academic staff to embrace new technologies in their teaching practices.

4 Conclusion

This case study , although limited in scope, has undoubtedly revealed several universal factors which can affect the take-up of learning technology, and of internet communication in particular. As the ICT revolution continues to impact on every area of higher education, providing support for both new and experienced university teachers is crucial to a successful shift to more flexible learning provision. The technology tools must become transparent to support effective teaching and learning, and this can only be achieved through practice, understanding of the pedagogy and awareness of the various options available [11]. This study has shown that by collaborating and sharing experiences and resources, universities can work together to create an effective staff development framework.

References

[1] Littlejohn, A.H. & Stefani, L.A.J. Effective Use of Communication and Information Technology: Bridging the Skills Gap ALT-J, 7.2, 66-76, (1999).

[2] Collis, B. Tele-learning in a digital world: The future of distance learning. London: International Thomson Computer Press, (1996).

[3] Harasim, L., Hiltz, S.R, Teles, L. & Turoff, M.,Learning Networks: a field guide to teaching and learning online, MIT Press, Cambridge, Massachusetts, (1995).

[4] Laurillard, D., Rethinking University Teaching: A Framework for the Effective Use of Educational Technology. London: Routledge (1993).

[5] Mayes, J.T. Dialogue With A Dumb Terminal, in the Times Higher Educational Supplement, October 10^{th}, 1997 http://led.gcal.ac.uk/clti/papers/thes.html (accessed on 1 August, 2000)

[6] Voss, L., European Network of Innovative Schools, Proceedings of Euro Education 2000, February 8-10^{th} Aalborg, Denmark, available on CD-ROM. (2000)

[7] Mayes, J.T., Learning Technology and Groundhog Day, Hypermedia at work: Practice and Theory in Higher Education, (Strang, W., Simpson, V., Slater, D., Eds) Canterbury, University of Kent Press (1995)

[8] Littlejohn, A.H. & Cameron, S., Supporting Strategic Cultural Change, ALT-J, 7.3, 64-75 (1999).

[9] Littlejohn, A.H., Stefani, L.J. and Sclater, N., Effective use of Technology, the Pedagogy and the Practicalities: A Case Study, Active Learning, 11, 27 - 30 (1999).

[10] National Committee of Inquiry into Higher Education, Higher Education in the Learning Society, London http://www.leeds.ac.uk/educol/ncihe/ (accessed on 1 August, 2000)

[11] Creanor L. & Littlejohn A.H., Preparing for Online Learning and Teaching: A Cross-Institutional Approach to Staff Development in Internet Communication, Journal for Computer Assisted Learning, 16,3, 271-279 (2000).

Comparing Computer Anxiety by Gender among Technological College Students in Taiwan

Shwu-yong L. Huang* and Yeon-Chaw Liu**

**Center for Teacher Education, National Tsing Hua University,*
Hsinchu, 30043 Taiwan
Tel.:(03) 571-5131 ext. 4534
Syhuang1999@yahoo.com
***Jin Wen Institute of Technology*
Taipei, Taiwan

This study investigates gender-related differences in computer anxiety and the variables related to male and female students' computer anxiety. Participants were 549 college of technology students, each was administered a revised Computer Attitude Scale. MANOVA results indicate that male students had significantly greater confidence and lower anxiety than female students. Male students rated more positively than female students on the following items: (a) I feel confident with my ability to learn about computers; (b) working with a computer would make me very nervous; (c) I am not the type to do well with computers; (d) I feel comfortable using computers; and (e) computers make me feel uneasy and confused. Multiple regression results reveal that male students' computer anxiety was influenced by their own locus of control and total number of computer courses taken. Female students' computer anxiety was influenced by the same two variables as well as by their subject majors. Age and grade level, however, showed no significant influence on these students' computer anxiety. Standard deviations were relatively large, suggesting there was a great variance among students responses. Educational implications of the findings are discussed in the paper.

Key Words: **Computer Anxiety, Gender Differences, Technology Education**

Gender as a differentiating variable in college students' computer use has been examined in a number of studies during the past two decades. Most of these studies are centered on students in colleges of liberal arts or teacher colleges. For example, Busch (1995) examined college students and documented gender differences in perceived self-efficacy regarding completion of complex tasks in both word processing and spreadsheet software, but not in simple tasks. Harris & Grandgenett (1996) found that gender is an attributing variable to teachers' anxiety in their use of networked resources. Very few research studies, however, have been specifically focused on students in technological colleges, assuming that these students receive adequate training in computer and technology, and are therefore least fear of using computer. It is important to understand the actual perceptions and needs of technological students and some influencing variables like gender on their computer use. Unrealistic assumptions may interfere the provision of educational programs that address their unique needs. Therefore, the purpose of this study is to investigate gender-related differences in computer anxiety, and to determine the variables related to male and female technological students' computers use.

1 Methods

The participants of this study were 549 college of technology students. Among them, 100 were male and 449 were female. These students majored in eight subject areas. About 96% of them were age 25 or younger.

About 86% of them had computers at home and over 60% of them had been working with computers for more than two years. Nearly 60% of them had taken two or more computer-related courses.

The instrument used in this study is the revised Teacher Computer Attitude Scale (Violato, Marini, & Hunter, 1989). It includes 10 items measuring computer anxiety and confidence on a 5-point Likert type scale. A score of 1 indicates that a student disagrees strongly to the statement and a score of 5 indicates that a student agrees strongly to the statement. The instrument has been found to be reliable and valid in previous studies (Huang, 1997; Huang & Padron, 1995; Liu, 1998). For the present study, the instrument was translated into Chinese for the use of participants in Taiwan. Content validity was verified by reversing the translation of Chinese survey into English by English teachers who had not seen the original English version. No revision was found necessary. The alpha reliability coefficient is adequate at .87. A few questions on students' demographic and computer background were also included in the survey.

The instrument was administered to students in mid of the academic year by experienced researchers. Students answered the questionnaire anonymously. Multivariate analysis of variance (MANOVA) was used to determine whether if there were significant differences in computer anxiety by gender. Follow-up univariate analysis of variance (ANOVA) was performed to determine where the differences were. A series of multiple regression was used to determine the variables related to male and female students' computer anxiety.

2 Results

The results indicate that college of technology students generally had above average confidence and below average anxiety in using computers. The item with the lowest score is "Computers make me feel uncomfortable," followed by "I get a sink feeling when I think of trying to use a computer". The item with the highest score is "I am able to do as well working with computers as most of my fellow university students".

MANOVA results indicate an overall significant difference in computer anxiety by gender ($F(10, 538) = 2.71$, $p < .01$). Male students had greater confidence and lower anxiety in using computers than female students. Table 1 presents the ANOVA results. Significant differences between male and female students were found in the following items: (a) I feel confident with my ability to learn about computers ($p < .05$); (b) Working with a computer would make me very nervous ($p < .05$); (c) I am not the type to do well with computers ($p < .05$); (d) I feel comfortable using computers ($p < .01$); and (e) Computers make me feel uneasy and confused ($p < .01$).

Table 1: Differences in computer anxiety between male and female technological college students

Indicator	Male		Female		ANOVA
	M	SD	M	SD	F
I fell confident with my ability to learn about computers	3.57	0.96	3.32	0.95	5.56*
Working with a computer would make me nervous	1.40	0.97	1.64	1.01	4.76
I get a sinking feeling when I think of trying to use computer	1.30	102	1.34	0.93	0.15
Computers make me feel stupid	1.42	1.13	1.41	0.99	0.02
Computers make me feel uncomfortable	1.24	1.06	1.33	0.89	0.78
I am not the type to do well in computers	1.66	1.05	1.94	0.98	6.63*
I feel comfortable using computers	3.58	0.90	3.26	0.79	12.84***
Computers make me feel uneasy and confused	1.46	1.17	1.79	1.13	6.76**

I think using computers would be difficult for me	1.39	0.94	1.42	0.80	0.42
I am unable to do as well working with computers as most of my fellow college students	1.36	0.94	1.42	0.80	0.42

* $p < .05$ ** $p < .01$ *** $p < .001$.

Multiple regression results reveal that students' locus of control of computer use, age, grade, year(s) of computer experience, computer(s) at home, subject majors, and number of computer courses taken have an overall significant effect on male ($F = 9.83$, $p < .001$) and female ($F = 30.86$, $p < .001$) students' computer anxiety. The R square value for male students equals to .43, suggesting that 43% of the variance in male students' computer anxiety may be explained by the seven independent variables. The R square value for female students equals to .33, suggesting that 33% of the variance in female students' computer anxiety may be explained by the seven independent variables. Stepwise regression results show that locus of control and the total number of computer courses taken have significant effects on male students' computer anxiety. On the other hand, students' locus of control of computer use, subject major, and total number of computer courses taken have significant effects on female students' computer anxiety.. Table 2 displays the regression results by gender.

Table 2: Multiple regression results of variables related to male and female students' computer anxiety.

Variables	Female		Male	
	Beta	p	Beta	p
Locus of control	.50	.0001	.58	.0001
Subject major	-.13	.0028	-.08	.4071
Age	.00	.9337	-.04	.6730
Grade	.02	.7176	.02	.8619
Length of computer use	.05	.2316	.07	.4361
Computers at home	.01	.7848	.08	.3368
Total number of computer courses	.18	.0001	.19	.0001

3 Discussion

The findings of this study indicate that there were significant differences in technological college students' computer anxiety by gender. Male students were more comfortable and had lower anxiety using computers than their female classmates. These findings support previous research on the impact of gender-related perceptions on computer anxiety among college and university students (Brosnan, 1998; Liao, 1999). Plausible explanations include that (1) female students majored in different subject areas than male students; (2) female students had taken fewer computer courses, and (3) social stereotype of computer proficiency. Computer and technology have been portrayed in the society as more appropriate for male than for female and thus influence male and female students' self-efficacy in using computers. Because freedom from anxiety has been found to be an attributing variable to computer achievement (Liu & Johnson, 1998), it is important to reduce computer anxiety among female students. This can be done by identifying the areas and sources of anxiety in computer use by female students, and design instructional technique that can reduce their computer anxiety (Ayersman, 1996; Ayersman & Reed 1995-86; Liu & Johnson, 1998; Presno, 1998). For example, Fitzgerald, Hardin, and Hollingsend (1997) developed a course in hypermedia authoring program and provided instructional strategies to help decrease participating education students' computer anxiety.

Findings of the present study have provided a better understanding of gender-related technological college students' computer anxiety, identifying several related variables, such as locus of control and courses taken. Future research needs to examine how these and other variables may be used to enhance equity among technological students' computer confidence and achievement.

References

[1] Ayersman, D. J. (1996). Effects of computer instruction, learning style, gender, and experience on computer anxiety. *Computers in the Schools*. 12 (4), 15-30.

[2]Ayersman, D. J., & Reed, W. M. (1996). Effects of learning style, programming, and gender on computer anxiety. *Journal of Research on Computing in Education*, 28, 148-161.

[3] Brosnan, M. J. (1998). The impact of psychological gender, gender-related perceptions, significant others, and the introducer of technology upon computer anxiety in students. *Journal of Educational Computing Research*, 18 (1), 63-78.

[4] Busch, T. (1995). Gender differences in self-efficacy and attitudes toward computers. *Journal of Educational Computing Research*, 12 (2), 147-158.

[5] Crable, E. A., Brodzinski, J. D., Scherer, R. F. (1994). The impact of cognitive appraisal, locus of control, and level of exposure on the computer anxiety of novice computer users. *Journal of Educational Computing Research*, 10 (3), 239-248.

[6] Harris, J, & Grandgenett, N. F. (1996). Correlates among teachers' anxieties, demographics, and telecomputing activity. *Journal of Research on Computing in Education*, 28, 300-317..

[7] Huang, S. L., & Padron, Y. N. (1997). Differences in prospective teachers' perceptions of computers: A cross-national study. In D. A. Willis & J. Willis (Eds.), *Technology and Teacher Education Annual*, 1997. Charlottesville, VA: Association for the Advancement of Computing in Education. 865-868.

[8] Huang, S. L., Waxman, H. C., & Padron, Y. N. (1995). Teacher education students' attitudes toward educational computing. In D. A. Willis, B. Robin & J. Willis (Eds.), *Technology and Teacher Education Annual*, 1995. Charlottesville, VA: Association for the Advancement of Computing in Education. 769-773.

[9] Liao, Y. K. (1999). Gender differences on computer anxiety: A meta-analysis. In the *Proceedings of the 10th International Conference of the Society for Information Technology and Teacher Education. Charlottesville*, VA: Association for the Advancement of Computing in Education. 1394-1399.

[10] Liu, L., & Johnson, D. (1998). A computer achievement model: Computer attitudes and computer achievement. *Computers in the schools*. 14 (3-4), 33-54.

[11] Liu, Y. C., & Huang, S. Y. (1999). Comparing technological and teacher college students' computer attitudes in Taiwan. In the *Proceedings of the 10th International Conference of the Society for Information Technology and Teacher Education*. Charlottesville, VA: Association for the Advancement of Computing in Education. 1406-1410.

[12] Presno, C. (1998). Taking the byte out of Internet anxiety: Instructional techniques that reduce computer/Internet anxiety in the classroom. *Journal of Educational Computing Research*, 18 (2), 147-161.

[13] Violato, C., Marini, A., & Hunter, W. (1989). A confirmatory analysis of a four-factor model of attitudes toward computers: A study of preservice teachers. *Journal of Research on Computing in Education*, 22, 199-213.

Computer Anxiety and Locus of Control – A Cross-National Comparison between Preservice Teachers in Taiwan and the United States

Shwu-yong L. Huang
Ed. D.Center for Teacher Education
National Tsing Hua University
Hsinchu, 30043 Taiwan
Tel.: (02) 2367-9500
syhuang1999@yahoo.com

This study compares computer anxiety of preservice teachers in the U. S. and Taiwan. Two research questions were addressed: (1) Are there significant differences in computer anxiety and locus of control between preservice teachers from the two places? (2) What are the factors that affect computer anxiety between preservice teachers in Taiwan and in the United States? Sample subjects were 355 randomly selected college of education students from both places. Two instruments were combined for data collection: Teacher Computer Attitude Scale and Computer Locus of Control Measure. Both instruments were tested for validity and reliability. MANOVA results reveal that there were overall significant differences in computer anxiety and locus of control between the two groups. In spite of college computer courses offered and mandated, preservice teachers in Taiwan demonstrated greater computer anxiety and lower locus of control than their counterparts in the United States. The results also show that locus of control and gender affect computer anxiety for preservice teachers in the United States. For preservice teachers in Taiwan, locus of control and length of computer experience have effects on computer anxiety. Plausible explanations include that students from Taiwan had fewer years of experiences working with computers, and greater needs to enhance their computer self-efficacy.

Key Words: **Preservice Teachers, Computer Anxiety, Locus of Control, Cross- Cultural Study**

Computer anxiety defined by Crable, Brodzenski, and Scherer (1994) is an anxious response by the individual to the anticipated or actual contact with computers. Most of the studies on teacher computer anxiety centered on investigating factors related to computer anxiety (Ayersman, 1996, Ayersman & Reed, 1995, Harris & Grandgenett, 1996; Huang, 1995) and ways to overcome resistance and fear of computer use (Jackson, 1997; Stone, 1998). Recent research has also documented that (a) computer anxiety has a debilitating effect on achievement in computer related learning (McInerney, McInerney, & Sinclair, 1994) and (b) computer achievement was a function of three attitude variables: enjoyment, motivation, and freedom from anxiety (Liu & Johnson, 1998). Few research studies, however, have focused on cross-national comparison of computer anxiety and locus of control among preservice teachers. It is important to examine computer anxiety cross-nationally because understanding the differences in computer anxiety among preservice teachers from other countries may enable teacher educators to reflect on their education system and teacher preparation programs and thus make necessary improvement. Such a comparative study may also identify universal variables and relationship between variables that are cross-culturally valid (Wubbels, 1993). Since individual's locus of control of computer use, whether the person is internally or externally focused, is closely associated with computer anxiety (Crable, Brodzenski, & Scherer, 1994), this study compares both computer anxiety and locus of control between preservice teachers in Taiwan and in the United States. More specifically, this study addresses two research questions:

1. Are there significant differences in computer anxiety and locus of control between preservice teachers in Taiwan and in the United States?

2. What are the factors that affect computer anxiety between preservice teachers in Taiwan and in the United States?

1. Methods

Subjects

The subjects were junior and senior students in education colleges from northern Taiwan and southern United States. Among all participants, 180 students from each place were randomly selected for study. Later on, five students' data from the United States found unusable and deleted, leaving 175 sample subjects for this group. Similar to the United States, most colleges offer introductory computer courses, and a computer related course is mandated for teaching certificate in Taiwan. The two groups of preservice teachers, however, varied significantly in their demographic variables. There were more male education students in Taiwan than in the United States. About 36% of preservice teachers from Taiwan were male whereas only 6% of preservice teachers from the United States were male. The preservice teachers in the United States were older than their counterparts in Taiwan. Nearly 60% of them were 25 years old or younger, whereas 85% of preservice teachers from Taiwan were in the same age category. Preservice teachers in the United States also had longer experience working with computers than their counterparts in Taiwan. Nearly 64% of them has two or more years of experience working with computers, but only 17% of preservice teachers from Taiwan had same length of computer working experience.

Instruments

Two instruments were combined for data collection: Teacher Computer Attitude Scale (Violato, Marini, & Hunter, 1989) and Computer Locus of Control Measure (Kay, 1986). Ten items from the Teacher Computer Attitudes Scale (Violato, Marini, & Hunter, 1989) were used to measure prospective teachers' anxiety and confidence in using computers. The Computer Locus of Control Measure (Kay, 1986) includes ten items measuring students' internal or external focus of computer use. All items are on a 5-point Likert-type scale. A score of 1 indicates "Strongly Disagree," a score of 2 indicates "Disagree," a score of 3 indicates "Neither Agree nor Disagree," a score of 4 indicates "Agree," and a score of 5 indicates "Strongly Agree" to the statement. In addition, a few questions about students' demographic background and computer working experience were also included.

The combined survey was translated into Chinese for the use of sample subjects in Taiwan. Content validity was verified by reversing translation of the Chinese survey into English by English teachers who had not seen the original English version. No revision was needed. Nonetheless, internal consistency test shows that three of the locus of control items were weakly correlated with other items and were deleted. The alpha reliability coefficient is .95 for computer anxiety and .79 for locus of control scale based on the sample subjects in the United States. The alpha reliability coefficient is .87 for computer anxiety and .61 for locus of control scale for the sample subjects in Taiwan.

Data Analyses and Procedures

The survey was administered at mid of the academic year to preservice teachers by experienced researchers in both nations. Multivariate analyses of variance (MANOVA) were used to compare all items responded by the two preservice teacher groups within computer anxiety and locus of control scales. Follow-up analyses of variance (ANOVA) were performed to determine where the differences are. Chi-square tests were used to determine whether there were significant differences in demographic variables between the two student groups. Finally, multiple regression analyses were used to determine variables significantly related to computer anxiety of the two groups of preservice teachers

2 Results

The MANOVA results reveal that there were an overall significant difference in computer anxiety (Wilks' Lambda = 0.4959, $F(10, 344) = 34.97$, $p < .001$) and in locus of control (Wilks' Lambda = 0.4018, $F(9, 347) = 73.76$, $p < .001$) between the two groups of prospective teachers. Follow up ANOVA tests reveal that the two preservice teacher groups differed significantly in nine out of the ten computer anxiety items and the seven locus of control items. The only item that shows no significant difference ($p < .01$) is "I am able to do as well working with computers as most of my fellow college students." Table 1 displays the comparative results for each item.

Table 1: Differences in Computer Anxiety and Locus of Control between Preservice Teachers in Taiwan and the United States.

Item	Taiwan M	Taiwan SD	U. S. M	U. S. SD	ANOVA F
Computer Anxiety					
* I feel confident with my ability to learn about computers	3.22	1.14	3.93	1.00	38.01**
* Working with a computer would make me nervous	3.36	1.11	2.20	1.05	101.20**
* I get a sinking feeling when I think of trying to use computer	3.42	1.00	1.34	1.06	143.04**
* Computers make me feel stupid	3.44	1.12	2.11	1.08	128.39**
* I am not the type to do well in computers	2.74	1.19	2.03	0.85	40.87**
* I feel comfortable using computers	3.01	1.10	3.80	1.02	51.78**
* Computers make me feel uncomfortable	3.31	1.09	2.30	1.16	71.70**
* Computers make me feel uneasy and confused	3.41	0.92	2.25	1.10	115.81**
* I think using computers would be difficult for me	3.46	0.87	1.19	0.88	250.94**
* I am able to do as well working with computers as most of my fellow college students	3.77	1.01	3.56	0.96	5.53
Locus of control					
* I could probably do just about anything I need to do with computers	2.63	0.99	3.37	1.05	46.77**
* I can make the computer do what I want it to do	2.72	1.22	3.19	0.87	17.56**
* I will probably never be able to work with computers effectively	3.64	1.12	1.91	0.80	209.20**
* If I had a problem using the computer, I could solve it one way or another	3.18	1.00	3.47	0.95	7.84*
* I would never use computers if someone wasn't pushing me to do so	3.33	1.46	2.05	0.90	113.79**
* I would be able to determine how computers are used in my classroom	2.83	1.05	3.83	0.76	105.09**
* When something goes wrong with the computers, I feel there would be little I could do about it	2.33	0.93	2.75	0.97	17.04**

* $p < .01$. ** $p < .001$.

A series of multiple regression was conducted using demographic (gender and age), length of computer experience, and locus of control as independent variables to explore their effects on the two student groups' computer anxiety. Table 2 displays the multiple regression results.

Table 2: Multiple Regression Results of Gender, Age, Length of Computer Experience and Locus of Control on the Computer Anxiety of the Two Preservice Teacher Groups

Variables	Taiwan		U. S.	
	Beta	p	Beta	p
Locus of control	-0.57	.0001	-0.77	.0001
Gender	-0.04	.4379	.012	.0102
Age	<0.01	.9707	-0.03	.4780
Length of computer use	0.28	.0001	-0.04	.4433

The results reveal that locus of control has a strong negative effect on computer anxiety for preservice teachers in the United States. The greater locus of control they had, the lower was their computer anxiety. In addition, gender has significant effect on preservice teachers in the United States. Female preservice teachers had greater computer anxiety than male preservice teachers. The R square value equals to 0.65, suggesting that 65% of the variance in preservice teachers' computer anxiety may be explained by the four independent variables. For preservice teachers in Taiwan, locus of control also has strong negative effects ($p < .001$) on their computer anxiety. Length of computer use, however, has positive effect on their computer anxiety. The R square value equals to 0.47, suggesting that 47% of the variance in preservice teachers' computer anxiety may be explained by the same four independent variables.

3 Discussion

The findings of the present study reveal that there were significant differences in computer anxiety and locus of control between preservice teachers in Taiwan and in the United States. In spite of the college computer courses offered and mandated, teacher education students in Taiwan demonstrated greater computer anxiety and lower locus of control of computer competency than their counterparts in the United States. Preservice teachers in Taiwan had less confidence in mastering computer whether through the help of others or by their own effort. This finding is consistent to previous research studies which reported that preservice teachers in the United States had more positive attitude towards computers than those in Taiwan (Huang, 1997; Liao, 1996). This may partially due to the fact that preservice teachers in Taiwan had less experience working with computers than preservice teachers in the United States. Frequency distributions show that nearly 11% of preservice teachers in Taiwan never used computers, 29% of them used for less than six months, 21% used for six months to one year, 21% used for one to two years, and only 17% used for two years or longer. Less than adequate experience often produce greater anxiety. Other socio-cultural factors may produced attitudinal differences (Sensales & Greenfield, 1995) and need to be examined.

Findings of this study have educational implications. Teacher educators in Taiwan need to enhance technology proficiency, computer self-efficacy, and strategies for reducing computer anxiety and increasing confidence. For example, Pina and Harris (1994) suggested several teaching strategies that have been used in computer literacy courses. Some of the strategies are to (1) find the friendliest computer system, (2) give students a tour of the system, (3) tell them how it works, (4) start with simplicity and success, (5) teach self-regulated learning strategies, (6) use cooperative learning system, (7) keep their hands on the wheel, (8) let them know what computers can not do, (9) provide peers as lab assistants, and so forth. Although length of computer experience is an influential variable, negative quality of computer experience may also create anxiety (Gos, 1996; McInerney, McInerney, & Sinclair, 1994). Teacher educators need to provide user friendly environment like easy access, expert support, good facilities, and quality computer courses to enhance education students' computer competency.

For future research, educational researchers need to (a) identify other beneficial and negative instructional techniques and behaviors that are related to students computer difficulty, including Internet anxiety (Presno, 1998), and (b) explore individual characteristics associated with learning to use computer in preservice teacher preparation (Ropp, 1999).

References

[1] Ayersman, D. J. (1996). Effects of computer instruction, learning style, gender, and experience on computer anxiety. *Computers in the Schools*. 12 (4), 15-30.

[2] Ayersman, D. J., & Reed, W. M. (1996). Effects of learning style, programming, and gender on computer anxiety. *Journal of Research on Computing in Education*, 28, 148-161.

[3] Crable, E. A., Brodzinski, J. D., & Scherer, R. F. (1994). The impact of cognitive appraisal, locus of control, and level of exposure on the computer anxiety of novice computer users. *Journal of Educational Computing Research*, 10 (3), 239-248.

[4] Gos, M.W. (1996). Computer anxiety and computer experience: a new look at an old relationship. *The Clearing House*, 69, 271-276

[5] Harris, J, & Grandgenett, N. F. (1996). Correlates among teachers' anxieties, demographics, and telecomputing activity. *Journal of Research on Computing in Education*, 28, 300-317.

[6] Huang, S. L., & Padron, Y. N. (1997). Differences in prospective teachers' perceptions of computers: A cross-national study. In D. A. Willis & J. Willis (Eds.), *Technology and Teacher Education Annual, 1997*, (pp. 865-868). Charlottesville, VA: Association for the Advancement of Computing in Education.

[7] Huang, S. L., Waxman, H. C., & Padron, Y. N. (1995). Teacher education students' attitudes toward educational computing. In D. A. Willis, B. Robin & J. Willis (Eds.), *Technology and Teacher Education Annual, 1995*, (pp. 769-773). Charlottesville, VA: Association for the Advancement of Computing in Education.

[8] Jackson S. B. (1997). Overcoming faculty's fear and loathing: one principal's approach. *T.H.E. Journal*. 25, 65-66.

[9] Kay, R. H. (1993). An exploration of theoretical and practical foundations for assessing attitudes toward computers: The Computer Attitude Measure (CAM). *Computers in Human Behaviors*, 9, 371-386.

[10] Liao, Y. K. (1995). A cross-cultural comparison of computer attitudes among preservice teachers. In D. A. Willis, B. Robin & J. Willis (Eds.), *Technology and Teacher Education Annual, 1995*. (pp. 61-65). Charlottesville, VA: Association for the Advancement of Computing in Education. Association for the Advancement of Computing in Education.

[11] Liu, L., & Johnson, D. (1998). A computer achievement model: Computer attitudes and computer achievement. *Computers in the schools*. 14 (3-4), 33-54.

McInerney, V., McInerney, D. & Sinclair, K. E. (1994). Student teachers, computer anxiety and computer experience. *Journal of Educational Computing Research*, 11 (1), 27-50.

[12] Pina, A. A., & Harris, B. R. (1994). Preservice teachers and computers: Strategies for reducing anxiety and increasing confidence. Paper presented at the Annual Conference of the Association for Educational Communication and Technology, Nashville, TN.

[13] Presno, C. (1998). Taking the byte out of Internet anxiety: Instructional techniques that reduce computer/Internet anxiety in the classroom. *Journal of Educational Computing Research*, 18 (2), 147-161.

[14] Sensales, G, & Greenfield, P. M. (1995). Attitudes toward computers, science, and technology: A cross-cultural comparison between students in Rome and Los Angeles. *Journal of Cross-Cultural Psychology*, 26(3), 229-242.

[15] Stone, C. (1997). Overcoming resistance to technology. *The Delta Kappa Gamma Bulletin*, 64 (2), 15-19.

[16] Violato, C., Marini, A., & Hunter, W. (1989). A confirmatory analysis of a four-factor model of attitudes toward computers: A study of preservice teachers. *Journal of Research on Computing in Education*, 22, 199-213.

[16] Wubbles, T. (1993). Cross-national study of learning environments. In D. L. Fisher (Ed.), *The study of learning environments* (pp. 112-120). Perth, Western Australia: Curtin University of Technology.

Computer-Mediated Language learning

Shu Ching Yang
Graduate Institute of Education, National Sun Yat-sen University
shyang@mail.nsysu.edu.tw

1 Introduction

The Web provides a new learning environment with a wealth of pedagogic possibilities. The colorful and visually engaging appearance, rich resources, online audio, video, and other interactive features, combine to make the Web an enormously valuable learning tool. Although it has been argued that web technology has the potential to provide a unique environment for teaching and learning, the psychological implications of its effects on learners' language learning has remained relatively unexplored. The current research does not present much empirical evidence to validate the instructional applications of web technology [1-6]. Furthermore, results of a meta-analytical study, Ayersman found that perceptions and attitudes toward technology are functionally important in promoting effective learning [7]. Therefore, more research needs to be conducted into learners' perceptions toward this new technology so specific guidelines for its successful implementation can be provided.

This study looked at learners' attitudes and perceptions as they conducted technology-augmented projects, and asked what were their affective attitudes and cognitive perceptions toward this tool. The study contributes to an understanding of language learning using the Web, and provides a basis for empirical studies of Taiwanese EFL learners performing real educational tasks with the Web. The insights gained in this small study will help EFL teachers design better learning environments with regard to classroom management, assessment and assignment.

2 Methodology

Participants

The 55 participants in this study were second year students, majoring in Applied English at a junior college. They had taken a 2-credit required course in Tourism English for two semesters.

Web-based Language Project

The goal of this project was to apply the language that the students had learned in an authentic context, to communicate, and to nurture students' global perspectives and information literacy. The project aimed to help students understand the Web with the ultimate goal of using it to create research projects about selected states in the U.S. Specifically, the objectives for the project were to: (1) provide students with background information about American culture, its separate states, cities, food, customs, people, history, travel information, etc. (2) provide students with an information-literate experience in web technology; (3) enhance students' discourse synthesis ability, namely, learning how to search, organize, and compose information for a research project. Students were asked to work on conducting a search of an assigned American state on the Web. Students could create their projects in whatever format they would like.

Instruments

A questionnaire was given to elicit relevant information on the participants' perception of, and attitudes towards, using the Web to complete their Web-based English projects. The first part of the survey pertained to background information. The second part consisted of 40 attitude and perception statements about learning experiences indicating levels of agreement or disagreement on a 5-point Likert-type scale with 5 standing for strong agreement. The Cronbach coefficient alpha of the survey was .87, suggesting the internal reliability to be quite acceptable. The third part included open-ended questions depicting their reflections about the project.

Data Collection and Analysis

After data collection, the quantitative and qualitative methods were performed. The qualitative analysis made from the student responses to the open-ended questions and the researcher's observation, provided the opportunity to uncover deeper issues than might have been apparent in a quantitative study. Results from the factor analysis (principal axis factoring with varimax rotation) yielded six factors accounting for 64.11 percent of the variance. Following are the interpretations of each factor: cognitive disorientation, learning anxiety, perceived enhancement of language ability, perceived enhancement of cultural understanding, as well as the Web as a potentially useful search tool, and the overall perception of language learning on the Web.

3 Discussion and Conclusion

The study investigated second-year junior college students' attitudes and perceptions towards the web as an educational resource. Six main factors concerning the learners' perceptions were identified, including cognitive disorientation, learning anxiety, perceived enhancement of language ability, perceived enhancement of cultural understanding, as well as the Web as a potentially useful search tool, and the overall perception of language learning on the Web. The study showed that the reaction of students to technology-augmented assignments was mixed. Analysis of the survey revealed a generally positive attitude towards the project pertaining to the enhacement of cultural awarenss and overall language learning. A few negative responses were noted, as learners experienced varying degrees of disorientation and cognitive overload. In particular, those learners who do not adjust well to reading on the Web appear to have much learning anxiety and cognitive disorientation, and correspondingly, have a lower overall perception of language learning.

Some frustration with the challenges and difficulties in relation to computers and language were found. On the one hand, students' encountered technical difficulties in relation to the use of computers. The problems they encountered were; malfunctioning of the system, the periodic slowness of Internet connections, poor design of web documents, searching complications, time constraints and the inconvenience of being required to work on the project on campus. On the other hand, students commented on the challenges of reading, selecting, processing and evaluating information. For example, some learners had not developed effective searching strategies for locating appropriate information and, further made qualitative judgments as to the accuracy and reliability of specific information. Given the fact that interest is the impetus of learning, and method is the key to knowledge, teachers should inform learners of effective learning strategies and design diversified learning enviroments by providing intellectual, entertaining and interesting assignmets to enhance learners enjoyment. From this study, it could be concluded that computer-learning networks have the potential to empower students in well-designed learning environments. It is emphasized that the central computer-mediated learning experience in Language Studies can not be achieved by itself simply by the introduction of the learner to the web technology. Those learners who show reluctance towards technologically oriented projects need careful guidance and support from the pedagogical and technological applications of this self-directed curriculum. Therefore, providing scaffolding, both in using Internet applications and in orienting the learners to the task, is vital to the successful implementation and integration of technology into the curriculum.

It is undeniable that, being situated at the turn of 21 century as we are, developing the learner's information literacy of the digital world is important. Learning to navigate and sift through huge amounts of information with speed and accuracy, as well as pursuing a critical level of understanding that goes well beyond literal or surface-level meaning, will prepare students for the challenges they will face as society delves deeper into the Information Age. The study calls for the learners' instrumental use of web technology to achieve language-specific goals. The project challenges learners to become both language and information literate in growing the following skills: awareness of global issues and concerns, the cross-cultural comparison, development of computer skills, enhancement of critical thinking and problem-solving skills, as well as specific communication skills such as arguing, persuading, or defending a particular point.

As the study shows, researching language instruction within a digital learning environment opens up a broader range of connections and meaning-making among learners. The present study is only a stepping stone on the way to examining learners' perceptions and attitudes toward the Web-based language project. Although this activity was conducted in a foreign language class, it could be adapted as an activity in a variety of disciplines to maximize the language dimension, such as social studies, global education, science, and cultural comparison [8]. The researcher believes that the possibilities for research in these powerful network environments will be conducive to broadening and refining language literacy.

References

[1] Bicknall, J., " Promoting writing and computer literacy skills through student-authored web Pages", TESOL Journal, Vol 8, No. 1, pp. 20-26, (1999).

[2] Green, A., "A beginner's guide to the internet in the foreign language classroom with a focus on the World Wide Web", Foreign Language Annals, Vol 30, No. 2, pp. 253-264, (1997).

[3] Garza, T., "The message is the medium: Using video materials to facilitate foreign language performance", Texas Papers in Foreign Language Education, Vol 2, No.2, pp.1-18, (1996)

[4] Lee, L., "Using internet tools as an enhancement of c2 teaching and learning", Foreign Language Annals, Vol 30, No. 3, pp. 410-27, (1997)

[5] Rankin, W., "Increasing the communicative competence of foreign language students through the FL chatroom", Foreign Language Annals, Vol 30, No. 4, pp. 542-546, (1997)

[6] Warschauer, M., "Computer-mediated collaborative learning", Modern Language Journal, Vol 81, No. 4, pp. 470-481, (1997)

[7] Ayersman, D., "Reviewing the research on hypermedia-based learning", Journal of Research on Computing in Education, Vol 28, No. 4, pp. 500-526, (1996)

[8] Moore, Z., " Technology and teaching culture in the L2 classroom: An introduction", Journal of Educational Computing Research, Vol 20, No., 1, pp. 1-9, (1999)

Do they do as they say? An exploration of the gap between the discourse and the application of socio-constructivist principles of pre-service teachers using ICTs.

Jacques Viens*, *Université de Montréal*, **Geneviève Légaré****, *Université Concordia*

*Jacques Viens
Faculté des Sciences de l'Éducation, Université de Montréal,
C.P.6128, succursale Centre Ville
Montréal (Québec) H2C 3J7
Tel.: (514) 343-7033
E-mail: viens@scedu.umontreal.ca
**Geneviève Légaré
Department of Education, Concordia University
1455, boul. De Maisonneuve Ouest
Montréal (Québec) H3G 1M8
Tel.: (514) 848-2030
E-mail: legare@vax2.concordia.ca

The purpose of this short paper is to present the preliminary results of our exploratory research concerning the impact of information and computer technologies (ICTs) on students' perception about their role as future elementary school teach ers. More specifically, we are trying to determine which factors, when ICTs are used as instructional support, are likely to facilitate the shift from a teacher-centered approach to a more genuine learner-centered approach. Using student interventions in telediscussions and the pedagogical scenarios as data sources, we outlined two general trends. First, students who demonstrate critical thinking abilities in telediscussions are more likely to apply successfully their constructivist values and beliefs in their productions of integrative scenarios. Secondly, students who do not support their opinion in the telediscussions will be less able to apply constructivist principles to their productions, where the learners are truly at the centre of their learning.

Keywords : **On-line education, teaching and learning processes, pre-service teacher education, socio-cons tructivism**

1 Introduction

The purpose of this short paper is to present the preliminary results of our exploratory research concerning the impact of information and computer technologies (ICTs) on students' perception about their role as future elementary school teachers. More specifically, we are trying to determine which factors, when ICTs are used as instructional support, are likely to facilitate the shift from a teacher-centred approach to a more genuine learner-centred approach. To do so, we are using, as data sources, the student interventions in telediscussions and the pedagogical scenarios (hereafter integrative scenarios) that were produced on the web.

2 Context

Students registered in our teacher education programme have to take a minimum of two courses about the integration of ICTs in the classroom. The first course (ETA1700) is a general overview of the various technologies that could be integrated in a given learning environment. The final assignment consists of producing, as a team, a complete and fully working integrative scenario that will be available on the Web, for the benefit of their colleagues and the teaching community. To develop their scenarios, the students have access to our instructional model that favours a scaffolding strategy. The creation of the scenario includes the following steps : needs analysis, development of the content, selection of a learning approach and the development of a lesson plan. In a socio-constructivist approach, students are free to choose the subject-matter, the grade level, the pedagogical approach, the teaching tools and medium. As the teams develop their integrative scenarios, individual members are invited to participate in telediscussions. For the course ETA1700, four themes are provided : the impact of ICTs on society, the effective use of ICTs in educational settings, the changing role of teachers and learners and continuing education of teachers. Since learning to use the technology is a sub-goal of the course, students are requested to make at least one contribution for each theme, as well as offer one reply to one of their colleague.

The second course, PED2000, is a full year course, offered to second or third year students and mostly at a distance. Team members are free to meet as they please. Using the same scaffolding approach, students have to produce a more comprehensive scenario for a situation of their choice. However, prior to designing their scenario, students have to contact an in-service teacher who will let the students conduct their intervention in his or her classroom. The field experiment allows the teams to conduct a formative evaluation of their project. PED2000 students also have access to electronic forums of discussion, with the difference that no themes have been pre-determined. It is the students who create and launch topics of discussion. An on-line tutor is available to guide the students in their creative process.

3 Description of the project

3.1 Object of research

As we mentioned earlier, our goal is to understand better the perceptions that students might have about the impact of technology on their future role as elementary school teachers. Ultimately, the research results will be used to improve an to enrich our scaffolding approach, in order to help the students not only discuss the socio-constructivists principles but adopt them in practice. To do so, we explored the links between the discourse held in the telediscussions and the application of the principles in the integrative scenarios.

3.2 Sampling

For this paper, we used only the one of the multiple sections of the ETA1700 course. We selected four integrative scenarios representing 18 students, who contributed 80 messages on the two relevant themes (perception about the role of the teacher and effective use of ICTs in the classroom). Since our goal is to explore the factors influencing the application of socio-constructivis t principles, we retained the projects that demonstrated some interdisciplinary and collaborative flavour.

3.3. Criteria for analysis

3.3.1 Integrative scenarios

To assess the students' perceptions about their changing role as teachers, we referred to some of the criteria described in Viens (1993) [1], as well as the general constructivist principles (Lave & Wenger, 1991; Brown, Collins & Duguid, 1989) [2] [3]. Even though we used a Likert scale to evaluate each criterium, our intention was not to cumulate frequencies. We rather used the scales to guide our critical analysis of the constructivist aspects of each scenario. Consequently, the results are more descriptive in nature.

The criteria are as follows :

Learning strategies . Notwithstanding the specific learning strategy to be used, we assessed whether the learner' s during the instructional strategy was « directed », « guided », « rather guided », or «free ».

Team work. We examined whether the students planned to have their learners work individually, in teams but to conduct a fragmented task, or in teams to conduct a collaborative and collective task.
Content. Did the students determine a specific content or did they leave it completely opened for their learners to decide of their subject, as it is usually done in project-based learning?
Pedagogical goals. Aside from the usual well-stipulated instructional goals, did the students add other learning objectives such as transversal competencies? To what extent did they consider incidental learning?
Interdisciplinary. Did the students focus on one subject matter or did they use the opportunity to integrate several disciplines?
It is to be noted that all criteria were considered simultaneously in order to assess the global constructivist flavour of each scenario.

3.3.2 Forums

For the forums we proceeded differently. First, we focused on two aspects : the positive/negative attitude toward the ICTs. Secondly, we looked at the perception of the teacher's role. In addition, we attempted to assess the student's capacity to reflect critically, that is we observed whether the students were able to develop and support their thoughts rather than merely contributing an unsubstantiated opinion (Quellmaz, 1987; Ennis, 1987) [4] [5].

4 Preliminary results

4.1 Forums

Attitude towards ICTs

After conducting the preliminary analysis of the telediscussions for the course ETA1700, we noticed that the students positions about the integration ICTs in the classroom are not radical as one might expect. The majority seems relatively sensitive and cautious about technologies. In fact, several interventions were concerned about the fact that the computer will never replace the teacher and that the human factor is essential for the development of the pupils. In other words, aspects such as empathy, communication, emotional support are still essential for the learners development.

Perceptions of the role of the teacher

After listing all relevant interventions, we noted three recurrent themes that could constitute categories. Some interventions directly mentioned the role of the teacher, whereas others were more or less related to the topic, but still touched on the perceptions of the teacher's role. The third group of interventions were concerned about more specific tasks of the teacher. We chose to use these categories to present the results about the perceptions.

Although not all interventions under the theme « Perception of the role as teacher » referred directly to the subject, it is interesting to discover that the perception of the role is indeed changing. The students did mention that the ICTs will help shift from a traditional role of « content deliverer » to one that assumes more guidance, more facilitation. Terms such as « facilitator », « animator », « councillor », « advisor » were used relatively frequently. However, we discovered that the students limited their intervention at the opinion level. They only named or listed the role without providing an explanation or a definition of what they meant by « facilitator » for example. Furthermore, they did not establish a priori what they view as a « traditional role ». Very few went as far as mentioning « content deliverer » or « lecturer ». In other words, students talk about the changing role without defining their assumptions. No one proceeded to compare and contrast the two positions or provide an illustration to support their thought. Indeed, the participants merely identified keywords and did not attempt to engage in a more critical discussion.

Some interventions were also addressing the issue of the changing role, but indirectly. Some students talked about the fact, for example, that the ICTs will provide the opportunity for the pupils to be more active in their learning process. Here, the guiding role of the teacher is implied in the discussion. Participants mention the possibility that ICTs will encourage the active construction process and consequently, will contribute to a more significant learning experience. In fact, in those indirect interventions, the learners are considered to be at the centre of their learning, actively engaged in the construction of their own knowledge and experience.

In sum, those students seem to think that ICTs can be used to favour collaboration between the learners as long as the learners' needs are respected. It seemed that participants perceive the ICTs as an integrated tool to teaching that favours self-learning.

The same group of students also discussed a specific aspect of teaching that will be affected by the technology : the impact of a broader access to information. Some students recognise the fact that a wider access to information will bring new tasks for their learners. One student mentioned that their pupils will have to « clarify their own research goals, define their information seeking strategy, make choices in the information, and sort the information ». This type of anticipation regarding « transversal » competencies was certainly an interesting discovery.

However, the same students who demonstrated their critical thinking abilities, still perceived themselves as the authority figure for their students. In fact, they mentioned that it will be their responsibility to assess the quality of information gathered on the Web as well as to judge the relevance of the source. Instead of making the link between the role of guide or facilitator as it would be expected in a constructivist fashion, it seems that the higher cognitive skills required, such as analysis and evaluation, will remain in the mind of future teachers, as their own territory.

4.1 Integrative scenarios

Two interesting trends have been identified in this analysis. First, the students who are more able to support their opinions by providing examples, using the literature, explaining their thoughts, seem to be more capable of producing a scenario that uses a genuine constructivist approach. In fact, if all the constructivist criteria are applied whenever it is reasonable to do so, the tone used to describe the learning activity is more opened, more respectful of both the freedom of the teacher and the learners. Here, we noticed that teams who produced a constructivist integrative scenario, were constituted of at least two members who demonstrated critical thinking abilities.

In the second trend, it seems that the students who claim that the role of the teacher is changing but who do not support their opinion, do not apply their values and perceptions in their integrative scenarios. In the telediscussions, they claim to be constructivist, but they fail to transfer their thoughts in practice. As we anticipated, the majority of the scenarios produced were meant to be constructivist. Some teams for example, will have their students work in teams but in a fragmented fashion (individual students will provide parts that will make a whole); the content will be determined and not opened for change; the learner will be rather guided in the learning process.

Two sources or information reveal the lesser constructivist approach : the instructional goal statement and the description of the lesson plan. Statements of the instructional goals in those scenarios tend to be highly fragmented, clearly measurable, well stated. Often, the students will refer to the Ministère de l'éducation du Québec programme to write the goals. There is no reformulation of the goals to suit their situation or needs. Also, there is no interpretation or critical analysis or re-evaluation of the goals. The students just take them as they come.

The design of the lesson plan is another indicator that a scenario might not represent a good application of constructivist principles. Lessons plans tend to be very organised and directed as well. The outcomes, ensuing the instructional goals, are well planned. In fact, the pre-service teachers, remain perfectly in control of the predetermined outcomes. Despite their good intentions, the students remain in control of the learning process. The steps are not only too well defined, that are also not flexible. The outcomes of the intervention using ICTs are still pre-determined and nothing else, that is no incidental learning is considered.

5 Conclusions

In this exploratory research we highlighted two trends. Students who demonstrate critical thinking abilities in telediscussions are more likely to apply successfully their values and beliefs in their productions of integrative scenarios. Secondly, students who do not support their opinion in the telediscussions will be less able to apply the constructivist principles to their productions. They will remain in control of their pupils' learning. The next logical step will be to determine how we could support the development of critical thinking skills in the telediscussions, in order to encourage a better transfer of the socio-constructivist principles to the development of integrative scenarios.

References

[1] BROWN, A. L. The advancement of learning. *Educational Researcher*, November, 4-12, (1994).

[2] BROWN, J.S., COLLINS, A. & DUGUID, P. Situated cognition and the culture of learning. *Educational Researcher*, Jan.-Feb., 32-42, (1989).

[3] COGNITION AND TECHNOLOGY GROUP AT VANDERBILT. Anchored instruction and its relationship to situated cognition. *Educational Researcher*, August-September, 2-10, (1990).

[4] DEAUDELIN, C. et VIENS, J. Éditeurs *Nouvelles technologies et formation : impacts sur les contenus et les stratégies d'enseignement/apprentissage.* Actes du colloque du CIPTE tenu au sein du 64e colloque de l'Acfas à l'université McGill. *Educatechnologiques* Volume électronique. http://www.fse.ulaval.ca/fac/ten/reveduc, (1997).

[5] ENNIS, R. H. A taxonomy of critical thinking dispositions and abilities. In J. B. Baron & R. J. Sternberg (Eds.), *Teaching thinking skills: Theory and practice* (pp. 9-26). New York: W.H. Freeman and Company, (1987).

[6] GERVAIS, F., GARANT, C., MAINGUY É et VIENS J. "Nouvelles formules pédagogiques en formation des maî tres : mise en commun." dans Gervais C., Garant, C., Gervais, Fl. et Hopper, C. Formation des maî tres entre cours et stages... un partenariat INTRA-universitaire? Sherbrooke : Éditions du CRP, (144 p.), p. 114-125, (1998).

[7] LAVE, J., & WENGER, E. *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press, (1991).

[8] QUELLMAZ, E. S. "Developing reasoning skills" in *Teaching thinking skills: theory and practice.* J.B.Baron and R.J. Sternberg, Eds. New York: Freeman, pp. 86-105, (1987).

[9] RIOUX, S. et, VIENS, J. Les télédiscussions comme outil de construction des connaissances dans la formation des enseignants. *In Guir, R. (Ed.), La formation des enseignants et des formateurs aux nouveaux usages et aux nouvelles pratiques des technologies de l'information et des réseaux, Volume 2: Les implications sur la formation des enseignants aux TIC.* Paris : Éditions De Boeck, (à paraî tre, automne 2000).

[10] VIENS, J. *Vivre une expérience d'auto-apprentissage collaboratif.* Seconde édition de l'INFODUC, le répertoire Internet de l'éducation. Québec : Septembre Média, p. 264-269, (1998).

[11] VIENS, J. Modelisa, a constructivist learning environment to foster collaborative self-learning and metacognition. In Hilding Sponberg, Zdena Lustogova & Stanislav Zelena (Eds.) *Telecommunications for Education and Training.* Prague : Charles Uninersity. p. 156-163, (1997).

[12] VIENS, J. Au-delà d'une certaine multidisciplinarité : Un prototype d'environnement informatisé permettant l'expérimentation d'outils pour la construction des connaissances. *Revue Educatechnologiques, 1*(2), pp.83-106, (1993).

[13] VIENS, J. et RIOUX, S. À propos du forum de discussion comme pivot d'une formule bi-modale d'enseignement. *Distance.* Automne 2000. 16 p., (à paraî tre).

[14] Site des Scénaristes : http://facvirtuelle.scedu.umontreal.ca/scenaristes

For example:

[1] VIENS, J. (1993). Au-delà d'une certaine multidisciplinarité : Un prototype d'environnement informatisé permettant l'expérimentation d'outils pour la construction des connaissances. *Revue Educatechnologiques, 1*(2), pp.83-106.

[2] LAVE, J., & WENGER, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

[3] BROWN, J.S., COLLINS, A. & DUGUID, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, Jan.-Feb., 32-42.

[4] QUELLMAZ, E. S. (1987). "Developing reasoning skills" in *Teaching thinking skills: theory and practice.* J.B.Baron and R.J. Sternberg, Eds. New York: Freeman, pp. 86-105.

[5] ENNIS, R. H. (1987). A taxonomy of critical thinking dispositions and abilities. In J. B. Baron & R. J. Sternberg (Eds.), *Teaching thinking skills: Theory and practice* (pp. 9-26). New York: W.H. Freeman and Company.

EDASEQ – A log file analysis program for assessing navigation processes

Helmut M. Niegemann
Institute for Media and Communications, Ilmenau Technical University, P.O. Box 100565, 98684 Ilmenau (Germany). Email: helmut@niegemann.de

Research on the effects of hypermedia learning environments often suffers from a lack of systematic control of learning conditions, especially the sequencing of the content. While available tools for logfile analysis are confined to delivering frequencies and other figures, the tool to be presented (EDASEQ: Exploratory Data Analysis for Sequential Data) was developed to facilitate the analysis of the navigation paths of single learners as well as "average" paths of a group of learners. Because standard statistical procedures for handling sequential data are not suitable here, the tool is primarily founded on graphical methods. Navigation processes are represented by transition matrices, and with additional visualizations and trajectories. Apart from descriptive portrayals, the tool also allows for categorizing empirically found navigation patterns on the basis of theoretically defined prototypical patterns. Furthermore, it is possible to compare the patterns of single learners or groups. Results can be used to better explain the effects of self-regulated learning in hypermedia learning environments. Without knowing variables like sequencing, time-on-task, or the number and configuration of examples studied by learners, it is hardly possible to interpret the impact of external learning conditions on the learning outcomes.

Keywords: **learning processes, navigation, hypermedia, methodology, tool**

1 Introduction

A fundamental problem of research on self-regulated learning is the possible variation of learners' behaviors, especially regarding variables like the sequence of content, the time spent with studying different parts of subject matter, the number and arrangement of examples and exercises: Have they really worked through all the relevant information? How many examples were chosen, with what methods of representation and in what combinations? How many exercises were worked through, and to what result, resp. with mistakes of what kind? How long were the learners occupied with what contents? This is valid for every type of research on self-regulated learning, but especially for learning with hypermedia. Even with the same context conditions, quantitatively and qualitatively completely different courses of learning are possible and thus, in consequence, very different results. Even when the learner activities displayed are described exactly, there are differences with respect to the quality of the elaborative treatment; the external conditions of the learning processes, however, are principally controllable. Unfortunately, standard statistical procedures are not suitable to represent an "average path" in an educational hypermedia system: Mean times spent on looking to specific pages or mean frequencies of visits are often not sufficient to explain differences in learning outcomes.

2 Aims of the development of EDASEQ[1]

For the description and categorization of such processes there thus remain graph theoretical procedures. There were already attempts at implementing these some time ago; the best known is probably Flanders' (1970) procedure for the analysis of teaching (cf. also Canter, Rivers & Storrs, 1985). For the treatment and

[1] Supported by the Deutsche Forschungsgemeinschaft (German Research Foundation), grant Az. Ho 649/9-1,2,3).

evaluation of data on the basis of graph theoretical considerations there is, however, as yet no method which is relatively simple to use. It was therefore an aim of the development of methods within the framework of a six year research project on case-based hypermedia learning environments in vocational training to develop a procedure allowing recorded data of learning processes to be so prepared that a) a data reduction is brought about which allows those processes to be analyzed exploratively, b) a categorization of typical processes becomes possible, c) records of several processes can be aggregated and finally d). Comparisons are made possible between (1) single records of processes, in order to see differences and similarities, (2) an individual process and an aggregated one, in order to be able to study deviations of single learners from the typical route taken in their group, (3) two aggregated processes, in order to compare groups under different treatment resp. marginal conditions using experimental designs, (4) a single or an aggregate process with a prototype process that is produced artificially, in order to categorize processes of one or several prototypes within the framework of defined deviations, or to test hypotheses. Apart from the characteristics of the processes, it should also be possible to extract simple statistics: e.g. frequency of the calling up of specific screen pages, specific transition frequencies, length of stay etc.

3 Forms of representation

In order to represent hypermedia navigation processes, there are first of all two different but mathematically equivalent codes: transition matrices on the one hand and aligned graphs on the other. Whilst one can see conspicuous characteristics in the graphical representation, the matrix representation allows the calculation of indices. Since both forms of representation are practicable, both should be taken into consideration. One special feature of well designed hypermedia learning systems is a structured presentation of knowledge given in such a way that learners have the choice of either informing themselves superficially or of going deeper into the subject at any chosen place, or of combining both courses of action: first gaining an overview, then deepening their knowledge. In order to determine the extent of the "deepening" - assuming an appropriate structuring of knowledge in the medium -, two characteristic values, the mean "depth of elaboration" and the "variance of elaboration" have been developed. The depth of elaboration is a rating for every hypermedia occurrence, which is all the higher, the deeper the corresponding screen page goes into a specific subject. If, for instance, the highest level with the index number 1 is the term "statistics", then pages on the subject "inference statistics" or "descriptive statistics" would have the index number 2 and a page on the subject "log-linear models" would have, for example, the index number 5. The arithmetic mean of the values of all screen pages visited could then give an indication of the extent of the "deepening" or "elaboration" of the material; the measurement is completed by the elaboration variance ascertained analogously. Not least, characteristics of the chronological process should be portrayable.

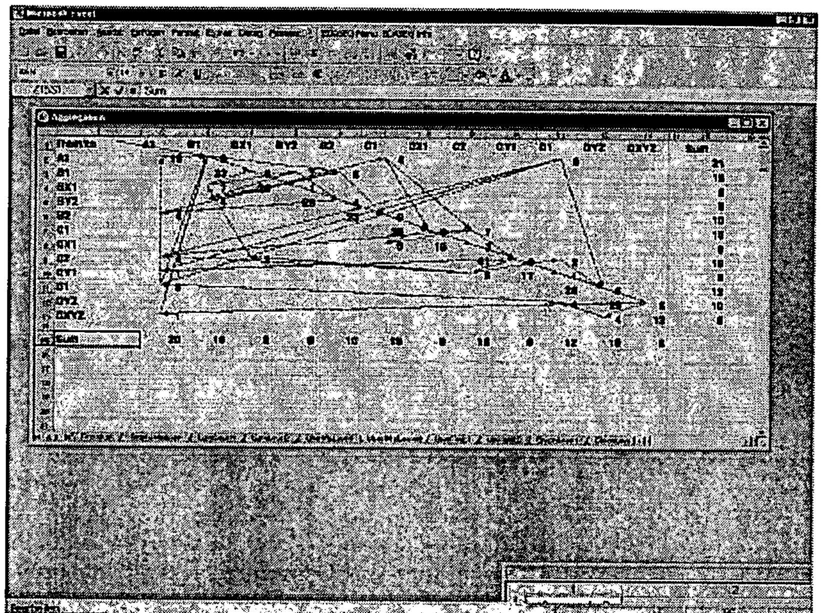
4 Realization

As the first step towards a reduction of process data in the Mannheim research project "Case-based learning problem" - in compliance with the demands - a software-technical evaluation procedure was developed. This enables processes to be transferred rapidly into transition matrices, so that firstly the simple frequencies of the consultation of specific pieces of information and of the transitions between offers of information can be ascertained. The learning programs developed in this project each encompass approx. 150 screen pages; learners need up to five hours to complete the given tasks and corresponding records comprise 3000 - 5000 single entries, each consisting of the time (in seconds after midnight) and the designation of the respective screen page. Log-files existing as ASCII text files are downloaded and converted into MS Excel files. For the simultaneous treatment of a larger amount of records it is also possible to stack them. Process data in the form of transition matrices can furthermore be compared to each other and also aggregated. In order to reduce data one can also stipulate that transitions which are more seldom than a specified threshold value should be ignored.

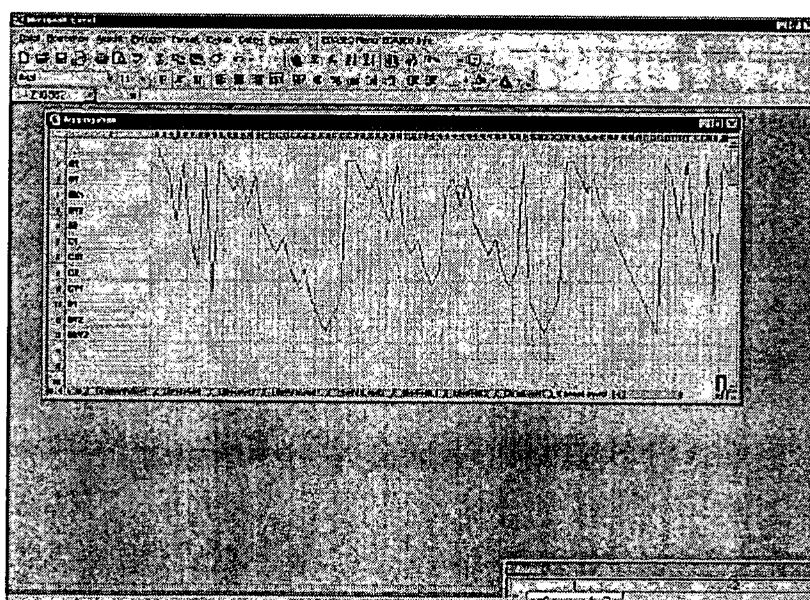
5 Examples of process representations and indices

The following representations are based on fictitious data; i.e. records were produced with the specific aim of representing certain processes, in order to determine whether the corresponding characteristics are perceptible. Apart from this the size of these records was to be restricted, in order to enable a written account to be given. shows the evaluation as regards the frequency with which single screen pages were called up, as well as the length of the stay there (absolute in seconds and relative to the complete time needed). Ills. 1 shows a transition matrix with aligned graphs of the process included (option). One alternative graphical representation ("chronological") is given in Ill. 2. Here, above all, recourses to previous steps are clearly to be seen: the test person would, in this case, have chosen a strategy whereby he/she began by choosing page B1 on the higher level, "deepening" from there straight to BX1, going back to B1, choosing another "deepening" (BY2) etc. The values in the main diagonal indicate how many time units the learner has here stayed on each separate page.

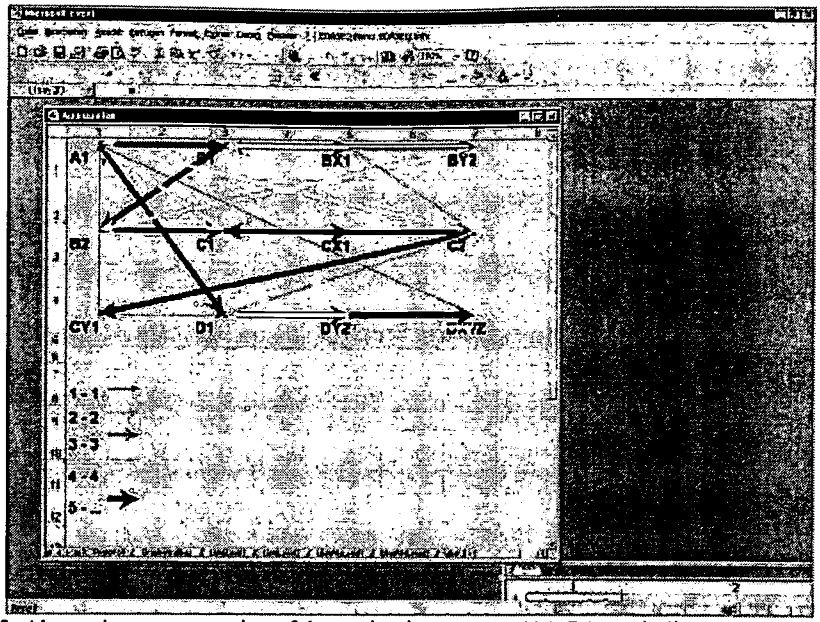
In a third, more concise representation of the process every node (page, screen, chapter etc.) is represented by one cell and the navigation process is shown by arrows between the cells. Analyzing aggregated data, the thickness of the arrows indicates the frequency of the transitions between two nodes. So, a sequence of thick arrows represent a "modal path", i.e. a path used by many users. (Ill. 3)



Ill. 1: Transition matrix with process graph included (A1, B1 etc. indicate screen pages)



Ill. 2: Linear representation of the process (A1, B1 etc. indicate screen pages)



Ill. 3: Alternative representation of the navigation process (A1, B1 etc. indicate screen pages)

6 Conclusion

The procedure which has been developed is first of all explorative, i.e. data are so prepared and represented that they allow categorizations and comparisons, thus offering a basis for the forming of hypotheses. Very extensive record files, in particular, are reduced. Although the procedure for the analysis of records on navigation was developed in hypertext, resp. hypermedia systems, it is also suitable for the treatment and analysis of data on the observation of teaching or other courses of communication.

References

[1] Bishir, J. W. & Drewes, D. W. (1970). Mathematics in the behavioral and social sciences. New York: Harcourt, Brace & World.

[2] Canter, D., Rivers, R. & Storrs, G. (1985). Characterizing user navigation through complex data structures. Behaviour and Information Technology, 4, no. 2, 93-102.

[3] Clarke, J. & Holton, D. A. (1994). Graphentheorie. Grundlagen und Anwendungen. Spektrum: Heidelberg

[4] Flanders, N. (1970). Analyzing teaching behavior. Addison-Wesley: Reading.

[5] Olson, G. M., Herbsleb,J. D., & Rueter, H. H. (1994). Characterizing the Sequential Structure of Interactive Behaviors Through Statistical and Grammatical Techniques. Human-Computer Interaction, 9, pp. 427-472

[6] Sanderson, P. M. & Fisher, C. (1994). Exploratory Sequential Data Analysis: Foundation. Human-Computer Interaction, 9, pp. 251-317

Evaluating educational multimedia: a case study

Elizabeth A. Kemp and Raymond H. Kemp
Institute of Information Sciences and Technology,
Massey University, Palmerston North, New Zealand
E.Kemp@massey.ac.nz, *R.Kemp@massey.ac.nz*

Following constructionist principles, postgraduate students who were studying a paper on Human Computer Interaction were required to build educational multimedia systems and then to evaluate those produced by their colleagues. The experience of developing a multimedia system, together with lectures and access to general material on the topic, enabled them to provide valuable insights into important issues. Nonetheless, the students were not, on the whole, able to transfer all that they had learned when building their own systems into an evaluation framework. The provision of scaffolding was recommended to facilitate transfer.

Keywords: **Multimedia, Evaluation, Constructionism**

1 Introduction

What are the criteria that should be used to judge the effectiveness of interfaces for multimedia tutorial systems? In an experiment with a class of postgraduate students studying Human Computer Interaction (HCI), they were asked to develop their own framework for evaluation. To give them some notion of what to look for and what to expect, they first had to form groups and construct their own multimedia tutorial systems. This approach is based on the idea of constructionism [6]. By collaborating in a group to develop some appropriate product, it is suggested that learners can come to a better understanding of the principles of a subject rather than by just being given the information by a teacher. This is in line with the wry comment from Jonassen *et al* [9] that the people who learn most from instructional materials are the designers.

The students were required to work together with one or two other classmates to produce their own small scale multimedia educational systems. Using the knowledge and experience they had gained, they then had to individually evaluate the interfaces of the other systems. There was no detailed specification about how to carry out these activities. The students had, however, been exposed to the main issues through lectures and discussions. They also had appropriate readings made available to them. The intention, therefore, was to see what the students, themselves, considered appropriate ways of evaluation in the light of their background and their experience in developing multimedia software. An assessment was then made of how much they had learned when building systems and how well the knowledge was applied to evaluating the systems of others.

2 Previous work

Interface evaluation can be carried out for many different purposes. The distinction is usually made between formative evaluation where improvements to a system under development can be determined and summative evaluation which assesses the overall performance [8]. There are a range of methods that can be used depending on the purpose of the study. Preece [12] categorises these purposes as analytic, expert, observational, survey and experimental. Analytic techniques are used to determine the complexity of the interfaces. Expert evaluation involves inviting people experienced with interface issues to identify usability problems. Observational, survey and experimental studies all have in common the involvement of what Preece terms "Real users." Users can be observed using software, provide feedback about the system through interviews or questionnaires or take part in experiments to test the impact of various features of the interface.

A common method of evaluation that does not involve users is expert evaluation where, as noted above, people with some knowledge of interface issues detect possible problems. This process can be conducted in accordance with the guidelines formulated by Nielsen and Molich [11]. The following aspects of the interface are all considered in what is referred to by these authors as a heuristic evaluation: simple and natural dialogue; speaking the user' s language; minimising user memory load; consistency; feedback; clearly marked exits; short cuts; good error messages; prevention of errors, and help and documentation.

An examination of the literature on multimedia reveals little mention of evaluation. Testing is usually discussed but not evaluation [4, 15]. Some important principles emerge, however. Alty [1, p33] points out that "A key question is when to use which media and in what combination to achieve the maximum effect." He also observes that success in multimedia depends more on the *combination* of media rather than on the provision of a rich set of media. Frater and Paulissen [5] note that interactive tutorials should allow the user to choose the starting point and allow the information to be accessed as often as required. They also offer this piece of advice. "Keep in mind that multimedia can make learning much more interesting when animation and sound files are used to explain the topic. Also a quiz is more fun when set up as a game" [5, p362]. Preece [12] points out that navigation, too, is an important consideration in hypertext/multimedia systems. Users, as she notes need to be able to know where they are, how they reached that point, where can they go next and how they get there. This as pect of interface design is actually covered by the first heuristic of Nielsen and Molich [11] which refers to "Simple and natural dialogue." This takes into account navigating through a system. Interface factors in interactive multimedia systems are also considered in Reeves and Harmon [13] and Tannenbaum [14].

One recent taxonomy in the literature provided by Heller and Martin [7] aims to help students on multimedia courses understand the forms of media as well as enabling them to evaluate the work of others. It has two dimensions - the media type and the means of expression (elaboration, representation and abstraction). This classification shows, for example, that text might be fully elaborated (large chunks of narrative), can be abbreviated (represented in bullet points) or might be abstract in nature such as text in a logo. Students are able to check whether a medium has been used in an appropriate fashion. As the authors state, though, the taxonomy takes no account of the effect of combining several media. Nonetheless, it is useful in focusing on the evaluation of each element. Detailed guidelines about how to use each medium, for example text, can also be found in Vaughan [15] and Collins [2].

3 Course structure

"Topics in Human-Computer Interaction" is a single semester paper for postgraduate students in Computer Science and Information Systems at Massey University. Most students have already completed a third year undergraduate paper "Human-Computer Interaction" in which the underlying theory is presented. These students will also have gained some experience in developing interfaces. The aim of this course is to consider issues of current interest such as computer supported co-operative work, innovative interfaces, different ways of evaluating the interface, multimedia systems and interfaces on the World Wide Web. Teaching is carried out through a mixture of lecturing, student seminars, discussion and demonstrations (of software such as Adobe Premiere and Macromedia Director). Students have available to them two books of readings which cover the material taught.

One assignment for this paper involved the students working in groups to develop a small multimedia system with an educational focus. The groups could choose any appropriate subject. Each student was then asked, individually, to evaluate the interfaces to all the other systems. A set of lectures had been given on the topic of multimedia including exposure to several life cycles for developing software of this kind. The topic of evaluation had also received considerable coverage in lectures and student seminars. Students were aware that interfaces can be evaluated for various purposes and in many different ways (for example by heuristic evaluation, interviews, questionnaires etc.)

Guidance on the life cycle that should be followed to develop the multimedia systems and the method of evaluation required was deliberately kept to a minimum. In the light of the teaching on the course and the material available to them, students were expected to make their own informed decisions. In particular, it was hoped that the students' own experiences in developing multi-media software would give them some insight into the criteria that should be employed when evaluating the interfaces to the other students' systems.

4 The student systems

Six groups each developed their own multimedia system. The systems were expected to offer instruction to their users and be interactive. A brief description of the systems follows.

Maori Language Tutoring

This system was designed to help students learn the Maori language. The study material was based on the philosophy that Maori be used wherever possible, with visual and aural stimuli to teach the vocabulary. Words were introduced via demonstrations using pre-recorded video clips. The system, however, also contained explanation in English for students who did not wish to completely immerse themselves in Maori. As well as learning new terms, students could choose to review vocabulary or test their comprehension. Maori music and designs were used in this system where the developers thought appropriate.

Learning the New Zealand Road Code

A written test on the New Zealand road code has to be passed before learner drivers can take their practical driving test. The aim of the road code system was intended to make the learning process more interesting. It was believed that by using animation, audio and video, the learning process would be enhanced. The system included tutorial material on aspects of the road code (for example, how to overtake or what to do when approaching a roundabout) as well as test material.

Earthquake Disaster System

The earthquake disaster system was developed to show people how to behave in the event of a serious earthquake. It included clips from a video developed by Civil Defence. Topics that were dealt with included planning for and coping with an earthquake. The opening screen showed a photograph of the devastation caused by a major earthquake. Music and animation chosen to reflect the theme of devastation accompanied the photograph.

Shape Recognition

The intention of the shape recognition system was to help children learn how to identify both two and three dimensional shapes in a lively and interesting way. Sound, animation and graphics were included in order to make the system appealing to children. Another goal of the developers was to make the system easy to use. There was a particular emphasis on the use of colour which was seen by the developers as making the system attractive to the intended users. The opening screen was designed to capture the attention of children with music and morphing shapes.

Introducing the Internet

This system, as its name implies, was intended to be introductory in nature. Its target group was school children who could find out about concepts such as email, newsgroups, file transfer protocol etc. This system made use of graphics, and sound but also included lengthy textual explanations. As with the shape recognition system, there was an emphasis on the use of colour. Ease of navigation was also a major consideration.

Undergraduate Studies in Computer Science

This system allows students to find out about the staff and the papers they teach in a Computer Science department. Photographs of staff members were included. When browsing through the system, users were able to move from a staff page to obtain information about papers taught by the staff member. Contextual information about the location of the building where the Computer Science staff were housed was also provided. The opening screen of the system showed a picture of the university grounds. Other pictures could also be viewed.

5 Educational Issues

Although the course does not deal with issues of computer-based learning, this was the focus of the assignment and gave the students some context for the systems they produced. They were expected to choose an approach to teaching which was appropriate for the subject that was being taught and that they felt would be effective in a multi-media setting. They all propounded he philosophy of their systems during their presentations. It is interesting to compare the different approaches that the students chose for their systems and how this was reflected in the presentation styles.

The Maori language teaching system immerses the student in the subject and attempts to teach by example. As noted earlier, the system can be used without reference to English words or phrases. Maori, like various other languages such as Japanese is very much bound up in the culture of the people and so this approach seemed entirely appropriate. Maori songs, words and phrases in a commentary with accompanying visuals provided a backdrop that was both stimulating and educationally appropriate.

The road code system contains video clips produced by the students themselves which graphically illustrated both correct and incorrect procedures to be followed in various situations when driving. This could be regarded as teaching by presentation and illustration.

Like the road code tutorial, the earthquake dis aster system has an emphasis on illustration using video clips and contains other factual information in an appropriate form.

Unlike the previous systems, the shape recognition tutor includes trial and error examples for the student to consider. It takes into account the answers the student gives and does not continue until it judges s/he has fully understood all the current concepts. It could be regarded as a mastery system from this point of view.

The internet system contains a great deal of informatio n in a text-based format, but the presentation was enhanced with appropriate animations. Material is set out in an simple to follow form and subjects can easily navigate around the system to discover what they need to know.

The undergraduate studies in Co mputer Science system also allowed students to learn about the department of Computer Science in a discovery mode. In some senses this was the package that was the least like a tutorial system, since it just provided information in a non-instructional form.

The underlying objective of the assignment was to determine whether or not students had assimilated a fundamental principle of HCI - that issues concerning functionality should not be divorced from interface concerns. Given the experience of developing a multimedia system, it was hoped that students would take into account the educational aims of the system as well as the multimedia features. It was not the object of the exercise, however, to see whether effective learning took place. It was expected that some variation of expert evaluation would be followed. What was of interest were the criteria that students incorporated into their checklist. Issues it was hoped would be addressed (in the light of the literature on this topic) included the following:

whether the interface reflected the educational objectives of the system;
the suitability of the media selected;
the user appeal of the systems;
the interface concerns;
evaluating the execution of the various media.

6 Results

Every student (thirteen in total) appraised all the systems developed by their colleagues. All the students provided a checklist of the criteria used for the evaluation - some were very detailed and others quite brief - from thirty items at one end of the scale to five at the other. The two students with the longest checklists evaluated whether the system fulfilled its objectives, the selection of multimedia components and the execution of the multimedia as well as detail of the interface such as the provision of feedback, ease of navigation etc. There were another three quite comprehensive taxonomies which covered many but not all of the relevant issues. Five students used Nielsen's [10, 11] guidelines for heuristic evaluation without adding to them to deal with the educational or multimedia aspects of the systems. The three students with the short checklists had incorporated rather broad categories such as ease of use, knowledge presentation, navigation, multimedia concerns and quality of knowledge which gave them reasonable but not complete cover of the relevant issues.

Expert evaluation can be carried out by anyone with appropriate skills and by more than one evaluator. In one case, two people evaluated the systems and combined their findings whilst on another occasion the student drew up the framework but did not carry out the heuristic evaluation himself. Some students scored the various items and averaged the results. This enabled systems to be ranked. Others did not attempt to provide an overall score for each system but left the findings to speak for themselves.

1. Did students check to see whether the interface reflected the educational objectives of the system?

In total, eight of the students included questions in their checklist which related to the educational nature of the system. Three of these explicitly mentioned the educational objectives of the systems under review before providing their assessment.

> *"This system is a multimedia tutor system designed to aid students in learning the Maori language. The system uses both visual and aural stimuli to teach words and concepts."*
> *"The system aims to provide information to undergraduate students."*
> *"It aims at helping children to learn a shape through playing which makes learning easy and fun."*

The eight students who considered the purpose of the system, that is its educational aspect, did not all ask the same questions. A variety of issues were covered as follows:

How does the system consider educational objectives?
Is the system suitable for intended users?
Who is the target audience?
Is the system aimed at the right audience?
Does the system have a reasonable informational content?
Is the quality of knowledge sufficient?

The evaluations included comments such as the following:

> *"Good way to teach a student with audio pronouncing the language and seeing the words on the screen."*
> *"Including some information on the properties of the different shapes and showing everyday examples of them would make learning the shapes a richer experience."*
> *"It does not really seem to be an educational system, more an informative system."*
> *"The current system does not seem to have a glossary page, A page for quick lookups and acronyms and jargon would probably be helpful."*
> *"It might have been good to have an option of telling users what the different shapes look like."*

Some of the students, however, not only evaluated the systems in accordance with their checklist but also in the light of their experience in appraising the programs. They mentioned, therefore, other important criteria in their assessments. One student centred her overall assessment around the suitability of a system for its purpose although this was not included in her criteria for evaluation. Two other students, also, mentioned educational issues such as whether the systems provided adequate content and comprehensible instructions.

> *"I had no idea what I needed to do and how the test was being processed."*

2. Did the students consider whether the mix of multimedia selected was appropriate for the stated purposes of the system ?

Only two students included in the guidelines for evaluation the need to consider whether suitable media were selected and used appropriately. One student asked the question "*Is the multimedia actually of use and not redundant*?" The other student checked that the mix of multimedia was used appropriately. This student noted not only occasions when a particular mix of media was ineffective but also when media was missing.

> *"The current system seems to rely too much on textual information. Improvements would be to make more use of video, diagrams and to provide more navigation options. These changes would give the user a more enriching learning experience."*

Many other relevant comments were made by the other students about an appropriate usage of multimedia, although they did not take the issue into account systematically.

"Of all the applications reviewed this has the most appeal due to its excellent usage of graphics and sound. The main area it could be faulted on is the large textual explanations given but these are offset by the following graphical examples."

"It uses multimedia such as sound and text making the system vivid and active."

Only one student fell into the trap of believing that a multimedia system had to incorporate all media. He would criticise a system that did not include video, for instance. No regard was paid to whether adding video would contribute to meeting the goals of the application.

3. Since educational systems have to be appealing to their users, did the students take this factor into account?

With regard to the appeal of a system, this issue was only expressly considered by four students. Related questions were as follows:

Is the system interesting and fun?
Does the user find the system visually appealing?
Has information been presented in an interesting manner?
Has the system an attractive presentation?

Comments made by these students include the following:

"Its creative design of the main menu ... and its appropriate use of the sound medium, make it enjoyable to use the system."
"There was no splash screen introduction. Whilst this may seem superfluous, good splash screens can be used to arouse a user's interest."

Three other students, however, did mention this issue. One of these was the student who did not carry out the expert evaluation himself. After watching the evaluation (according to Nielsen's guidelines as specified), he realised that the system he preferred obtained the lowest rating. He proceeded to base his overall assessment of the systems on whether they had an interesting and attractive interface. A second student also focused on the interest or lack of it in the programs. Of the Maori tutor, she said " *The welcome interface is impressive. The background and the music gives me some feeling of Maori culture.*" According to her, another system was a little bit boring.

An issue that relates to the appeal or attractiveness of a system is the appropriate use of colour. Four students included at least one item in their checklist concerning colour. Questions were as follows:

Are too few or too many colours used?
Is the colour in the system beautiful?
Does the use of colour help to make the displays clear?
Is the use of colour bad, normal, good or excellent?

One system was notable for its use of colour and several comments were made about this

"The very colourful shapes used are appropriate for the school based children as seen as being the intended users."
"The colour used in the system is beautiful."
"Good colour choice, relaxing."

This was not the only the system to make effective use of colour, however and one student observed in his conclusion that no-one made the mistake of using too many colours.

4. What typical interface factors were considered?

All of the students checked for at least one well-known interface concern such as consistency, clearly marked exits etc. Seven of them specifically included the guidelines for heuristic evaluation by Nielsen and Molich [11] or the updated version by Nielsen [10] in their checklist.

It was also expected when considering interface issues that the importance of navigation in interactive instructional systems should be recognised. It should not be just one more item in a checklist. Eleven of the 13 students took account of this issue.

> *"No stop, rewind or scroll bars for video."*
> *"Gives reasonable freedom to navigate backwards and forwards."*
> *"Not very flexible, very linear in its execution."*
> *"It is very easy to get "lost" while navigating through the system. No "back" button provided."*
> *"Clicking at various places in the window may move you to unexpected screens."*
> *"With the test screens there is no title indicating this."*
> *"Have no idea what I am supposed to do in the first screen."*

Four of the students highlighted the importance of navigation. Three incorporated this into their framework as a high level criteria. A fourth not only checked how users moved around the system but whether or not the users would know where they were in the system.

5. Did the students evaluate the multimedia components of the system?

Four students evaluated the execution of the individual media. Two of these assessed the effectiveness of each component: video, sound, graphics, text etc. by rating them on a scale. The third student concentrated on text and icons. His section on text was quite detailed, checking the length of the sentence, whether it just focused on one issue, and whether there was sufficient white space around it. The fourth student checked that the multimedia was not "over the top".

> *"When the system explained the Maori words, text is well organised."*
> *"I liked the use of Maori music with the splash screen."*
> *"Liked the introduction - morphing shapes."*
> *"Widely accepted icons are used to aid page-based navigation."*
> *"The background music is excellent. The button clicking sounds great."*
> *"Image excellent. When the system first starts, the animation is creative and attractive."*

7 Discussion

Reflecting on the results of the assignment, it became clear that learning about multimedia evaluation took place at various points in time. Most of the systems developed by the students were stimulating to watch. As developers the students were clearly aware of the need to use appropriate media in suitable combinations [1] and of the requirement to navigate easily through the system [12]. Some of what they had learned was reflected in the checklists that they developed for evaluating the systems of others. There was a difference, however, between the criteria specified by students for evaluation and those actually used when making their overall appraisals. These sometimes took additional factors into account that had not been included in the stated checklist. The experience of evaluating the systems themselves, allowed further learning to take place. It will be the more complete list of factors that are considered in the remainder of the discussion since the experience gained from carrying out appraisals is important and should not be discounted.

Eleven students checked to see whether the interface reflected the educational objectives of the system and two of these also considered whether the mix of multimedia was appropriate for the stated purposes. All of the students considered at least one relevant interface factor (consistency, clearly marked exits, etc). Six of the students also realised the need to find out whether or not a system would appeal to users. Four students included assessment of media components in their appraisals, however none of their questions showed a deep understanding of media issues.

It was pleasing from an educational perspective that most of the students when carrying out their evaluations took account of the functionality of the system. This cannot be divorced from interface considerations as for many users the interface is the system and must deliver the appropriate functionality.

Interface issues, too, were seen as important by all of the students. Of these, 11 checked to see whether a user could easily navigate around the program. This is an important issue in interactive multimedia systems and was recognised as such by the students. Eight of the students carried out a reasonably comprehensive evaluation of traditional interface concerns but for five it was rather rudimentary. This was surprising given the emphasis on the heuristic evaluation in the undergraduate and post-graduate courses.

Overall there were only two students whose evaluation was limited to just those interface issues covered by Nielsen [10, 11]. This meant that they excluded educational considerations, the appeal of the interface, an evaluation of the individual media and whether or not they were used in appropriate combinations.

A major weakness in the student evaluations' overall was the failure to consider whether the mix of multimedia selected was appropriate for the purpose of the system. Whilst the students did consider educational issues at a high level, they found it difficult to move to a detailed perspective, that is were suitable media selected and combined? This may involve greater knowledge of the potentialities and problems of the individual media than the students possessed. They tended, therefore, to have an overall impression of a system. This was reflected again in the failure of two thirds of the students to evaluate the execution of each media component.

Around 50% of the students did not take appeal/interest and fun sufficiently into account. This can possibly be attributed to the fact that they were not the intended users of the systems. If they had been drawing up a list of questions for users to answer they may have incorporated this. Nonetheless, it was an important omission as multimedia systems set out to interest and hold the attention of their users.

As the above discussion shows, students were particularly weak in considering what was to them the new area of multimedia. They did not appear to have the knowledge or experience to determine how to evaluate the media. They were given some exposure to these issues in lectures but do not appear to have followed them up. Whilst no one student came up with a complete checklist for evaluating multimedia systems, amalgamating the items in their checklists enables a comprehensive framework to be developed. See Appendix 1 for the main features of this. In future it may be preferable to provide students who have built a multimedia system with some scaffolding to help with the evaluation phase. Scaffolding [3] refers to supports that can be provided by a teacher to students. The main headings in the taxonomy outlined in the Appendix could be provided. The students could then be asked to develop appropriate questions for each area.

8 Conclusions

The students learned a great deal by building multimedia software and evaluating the systems of others. This was reflected in the perceptive comments of the students made in their written assignments. It was not always reflected, however, in the frameworks for evaluation that they developed, only two of which were comprehensive. Certain areas were handled well by the students, for example checking that each system was suitable for its purpose and the importance of navigation. Two significant issues, though, were only identified by a minority of the students – the need to choose appropriate media and to determine how well they had been produced. It appears that because the area of multimedia was new to the students, they needed more scaffolding in place to be able to learn from their own experiences. Instead of developing an evaluation framework from scratch, some initial information can be given to students in future that they then have to flesh out.

References

[1] Alty, J. L., Multimedia – "What is it and how do we exploit it?" In D. Diaper & N. Hammond. (Eds.), People and Computers VI, pp. 31-44, Cambridge: Cambridge University Press, (1991).

[2] Collins, A., "What different media do best", In The Six International Conference on Computers in Education, Beijing, (1998).

[3] Collins, A., Brown J.S., & Newman S. E., "Cognitive Apprenticeship: Teaching the craft of Reading, Writing and Mathematics", In L. B. Resnick (Ed), Knowing, Learning and Instruction, Hillsdale, New Jersey: Lawrence Erlbaum, (1989).

[4] England, E., & Finney, A., "Managing Multimedia", Harlow: Addison-Wesley. (1996).

[5] Frater, H., & Paulissen, D., "Multimedia mania : experience the excitement of multimedia computing", Grand Rapids: Abacus. (1993).

[6] Harel, I. (Ed.), "Constructionist Learning", Boston: MIT Press, (1990).

[7] Heller, R., & Martin, C. D., "A Media Taxonomy", IEEE Multimedia, 2(4), 36-45. (1995).
[8] Howard, S., & Murray, D. M., "A Taxonomy of Evaluation Techniques for HCI", In H. J. Bullinger & B. Shackel (Eds.), Human Computer Interaction. Interact' 87, pp. 453-459, Amsterdam: North Holland. (1987).
[9] Jonassen, D. H., Wilson, B. G., Wang, S., & Grabinger, R. S., "Constructivistic uses of expert systems to support learning". Journal of Computer Based Instruction, 20(3), pp. 86-94, (1993).
[10] Nielsen, J., "Enhancing the explanatory power of usability heuristic", Proc. ACM CHI'94 Conf. (Boston, MA, April 24-28), 152-158. (1994).
[11] Nielsen, J., & Molich, R., Heuristic Evaluation of User Interfaces. In J. C. Chew & J. Whiteside (Eds.), Proceedings of CHI' 90: Human Factors in Computing Systems, pp. 249-256, New York: ACM Press. (1990).
[12] Preece, J., "Hypermedia, multimedia and human factors". In C. Latchem, J. Williamson, & L. Henderson-Lancett (Eds.), Interactive Media, London: Kogan Page, (1993b).
[13] Reeves, T. C., & Harmon S., "Systematic evaluation procedures for interactive multimedia for education and training". In S. Reisman (Ed.), Multimedia Computing: Preparing for the 21st Century, London: Idea Group Publishing, (1994).
[14] Tannenbaum, R. S., "Theoretical Foundations of Multimedia", New York: Freeman, (1988).
[15] Vaughan, T., "Multimedia: Making it Work", Berkeley, Cal: Osborne McGraw-Hill. (2nd ed.). (1994).

Appendix 1

1. Does the system meet its objectives?
   - Who is the target audience?
   - Is the system suitable for the target audience?
   - Does the system include (in the case of educational systems) sufficient content?
2. Has an appropriate mix of multimedia been selected?
   - Have sound and text been used effectively together?
   - Have sound and graphics been used together effectively?
3. Will the program appeal to users?
   - Is the system fun?
   - Will the user find the system visually appealing?
   - Has the system a features that will pall over time e.g. an unusual sound or joke?
   - Has colour been used in an appropriate fashion?
4. Has the interface been properly constructed?
   - Is the interface consistent ?
   - Is help available when necessary?
   - Can users easily navigate around the system?
   - How does the user navigate around the system?
   - How does the user know where s/he is?
   - Is progression through the program logical?
   - Can the user start and stop as required?
5. Have the individual media been well-executed?
   - Is the text /graphics,/sound etc well produced?
   - Are the sections of text too long/too short?
   - Will the text be understood by the target audience?
   - Has text been expressed using elaboration, representation or abstraction?

Evaluation of class organization in the computer literacy education

Akira Harada*, Michio Nakanishi and Masashi Komori***
** School of Human Sciences, Osaka University*
Yamadaoka 1-2, Suita, Osaka 565-0871, Japan
E-mail: {harada, komori}@hus.osaka-u.ac.jp
*** Cybermedia Center, Osaka University*
Machikaneyama 1-30, Toyonaka, Osaka 560-0043, Japan
E-mail: naka@cmc.osaka-u.ac.jp

This paper compares two grouping strategies for teaching computer literacy at the university. The authors and their colleagues have been involved in the computer literacy education to 180 freshmen majoring in Letters and 150 freshmen majoring in Human Sciences for five years. In 1999, 180 students were organized into three classes at the early stage of the semester according to the student's wish, whereas 150 students were reorganized into three classes based on an achievement exam in the middle of the semester. The statistical analysis of exams and students' self-assessment showed that the early class organization was not so effective compared to the mid-term reorganization. The effect of mid-term reorganization was significant in the slow-learners class.

Keywords: **class organization, computer literacy education, self-assessment, teaching strategy**

1 Introduction

Computer literacy education in Japanese colleges and universities is facing a problem of diversity of students' computer skill levels. The reason for this is twofold. One is that very few high schools introduce the computer literacy education is into their curriculum. The other is that as computer price is falling down the number of students is increasing who have learned how to use word-processing or e-mails by themselves at home. This problem led us to study how to help our students learn this subject in good quality.

In Osaka University, the computer literary education has been a required subject for all freshmen since 1994. The computer literacy course consists of 15 sessions, and each session lasts 90 minutes, which includes demonstrations by a teacher and hands-on activities by students. Usually an assignment for each session is also given which will take an hour or two to complete. Three teachers including the authors have been teaching the computer literacy course to over 150 freshmen majoring in human sciences, and our three colleagues have been involved in teaching to 180 students majoring in letters.

In 1999, 150 students majoring in Human Sciences were organized into three parallel 50-student classes according to the enrollment order before the first session. In the middle of the semester, we gave an exam that includes hands-on work, such as word document processing, consulting online dictionaries, and finding web sites. Then we reorganized the three classes based on the exam score. Other background variables (age, gender and future academic field) were not considered for the class organization. The class organization aimed at ability grouping, that would provide non-experienced students with a slower work pace and allow high-achieving students to be sufficiently challenged by more demanding lessons. At the end of the semester, we again gave them an exam that would measure how they made progress.

As for the 180 students majoring in Letters, three parallel 60-student classes were reorganized according to the students' wish based on the questionnaire survey at the fourth session of the course. That is, the keywords of the three new classes, "slow and steady", "intermediate" and "intensive" were shown to students, and each student chose one of the classes.

In this paper, we begin with related work and a brief explanation of our computer literacy course, followed by the methodology of the class reorganization. Then, we present the statistical data analysis to show that class reorganization in the middle of the term was effective.

#1 Change this plain text file to rich text format, then change the font of the marked words to Ryumin 12 point, and place it in the center.
#2 Explain how to use Japanese Kana-Kanji translation and how to register your name in your own dictionary.
#3 Look up the three words (omitted here) in the following dictionaries: English-Japanese, Japanese-English, and Webster.
#4 Draw a tiny picture and insert it into this page.
#5 Find URLs of the National Diet Library and any two online book stores.
#6 Look into "/SharedLibrary/Literature/" and describe what's in it.
#7 What should be considered when you decide your password string?
#8 Find the specified string in the large file and copy the paragraph to the answer sheet.
#9 Describe how to cope with chain mails.
#10 Describe how to limit the line length to fewer than 65 characters in the body of an e-mail.

Table 1 Midterm exam sample in 1999

Touch typing	(poor) 1 2 3 4 5 (excellent)
Mouse operation (click, double click, drag)	(poor) 1 2 3 4 5 (excellent)
Window operation (resize, move, iconify, hide)	(poor) 1 2 3 4 5 (excellent)
Japanese Kana-Kanji translation	(poor) 1 2 3 4 5 (excellent)
File/Folder operation (move, rename, create)	(poor) 1 2 3 4 5 (excellent)
Word document processing (fonts, centering, insert graphics)	(poor) 1 2 3 4 5 (excellent)
Mail (MIME, signature, save to file, reply, delete, re-file)	(poor) 1 2 3 4 5 (excellent)
Web (search engine, book-mark)	(poor) 1 2 3 4 5 (excellent)
Use of online dictionary (Japanese, English)	(poor) 1 2 3 4 5 (excellent)
Canceling your printer job	(poor) 1 2 3 4 5 (excellent)

Table 2 Questionnaire survey for self-assessment

2 Related work

Although there have been much previous research on ability grouping, tracking, and class organization, they are mainly for K-12 school education, e.g. [4,9,10]. Furthermore, as far as the authors know, there has not been any research on class reorganization in the middle of a semester for computer literacy education. The authors have tried class reorganization for five years and presented its result obtained before 1998 in [5]. Our reorganization method is basically based on the exam score, but is not the same as cluster grouping.

3 Computer literacy education

Since the 1970s, the definition of computer literacy has evolved, and many researchers have discussed the courseware and teaching methodology of the computer literacy course, e.g. [2,3,4]. The authors believe that to learn details of word processing and spreadsheet application is not important but to grasp the concept and principal facilities of those applications is a key for students to become literate. Furthermore, the attitude to learn by himself or herself is also a key.

In the latest syllabus of the computer literary course in Osaka University, topics consist of two categories, "*Requisites*" and "*Options*".

Requisite category consists of the following items.

- File system, file operation, floppy disks
- Word processing, kana-kanji conversion (for Japanese characters)
- Concept of the Internet, network etiquette
- Electronic mail, web

BEST COPY AVAILABLE

- Draw and/or paint software
- Spreadsheet

Options are

- Net news
- LaTeX with graphics
- Writing HTML
- Mathematica
- SAS (Statistics)
- Script languages (perl, awk, shell, etc.)
- Computer ethics, social problems

Since one course session lasts 90 minutes and is held once a week, all topics of requisite category are the minimum competencies and are covered in about seven weeks. For the rest of one semester, teachers select some of the items from optional category depending on the students' majors. For example, LaTeX and Mathematica are selected for students majoring in Physics and Mathematics, while spreadsheets and SAS for Economics.

4 Class reorganization in the middle of a term

In this section, we explain the class reorganization method that we adopted in 1999. Then we show the examination scores and self-assessment scores of the three classes.

4.1 Reorganizing three classes by a hands-on performance exam

After we completed topics in requisite category, we set a mid-term examination that demands 1-hour hands on work, because there were differences between students how fast they got accustomed to computer operations in class. Table 1 shows the questions of the mid-term exam. We marked the examination papers out of 100 (each question of 10), and used the scores to reorganize the classes. The students who achieved more than 67 points were grouped into class A. The threshold between class B (50 students) and class C (50 students) was 52 points. The average total score was 60.3 (s=15.7).

The average scores of the new classes A, B, and C were 77 (s=7.4), 60 (s=3.9), 42 (s=7.5) points, respectively. The average score of class A students was more than 5.5 for all ten questions, whereas the students who were grouped into class C got only 2.2 and 2.3 for question #5 (web search) and #6 (file search), respectively, which were significantly lower than the other two classes.

4.1.1 Self-assessment by students

Before the mid-term exam, a questionnaire survey paper was distributed to the students. The survey consisted of 10 questions, which would measure students' mastery of competencies taught by that time (Table 2).

The answers to these questions were collected on a 5-point scale. The scores of the collected questionnaire showed a positive correlation between the exam and the students' self-assessments. That is, class A students felt good at the following competencies: inserting graphics into a document, operation of files/folders, and searching web site, whereas class C students answered that they had not mastered those topics. As for searching files from hierarchical file structure, class C students perceived that they were good at it; however, its exam score is poor. This indicates that class C students did not understand the file structure itself. Touch-typing and Email competencies were not statistically significant between three classes.

4.1.2 Curriculum after the class reorganization

The result of the exam and the questionnaire showed us what we should teach in the new classes after the class reorganization. We provided class C students with a slower work pace and revisited those competencies that they were not good at. For class A students, we gave lectures more extensively than other two classes and gave self-teaching assignment of LaTeX in the summer vacation.

In order to allow them to have an active participation in the shaping and augmenting of their learning, we also introduced self-teaching approach for learning spreadsheets in all classes. That is, after a brief explanation given by a teacher, students followed tutorials on the teacher's web pages. We had two teaching assistants each class, we asked them not to teach detailed step-by-step operations to the students but to help the students to find the way by themselves.

4.2 Evaluation of class reorganization

4.2.1 Statistical evaluations of exam and questionnaire

At the end of the course, we gave a self-assessment questionnaire survey followed by the term-end examination, which required hands-on work of about an hour. Here we begin with the analysis of the exam scores.

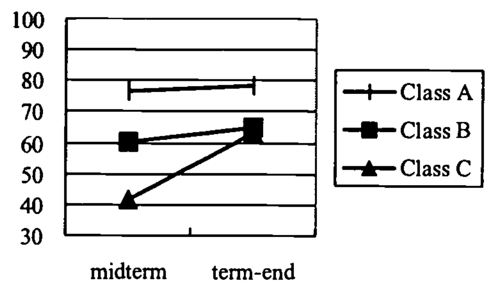


Figure 1 Total scores of midterm and term-end exams

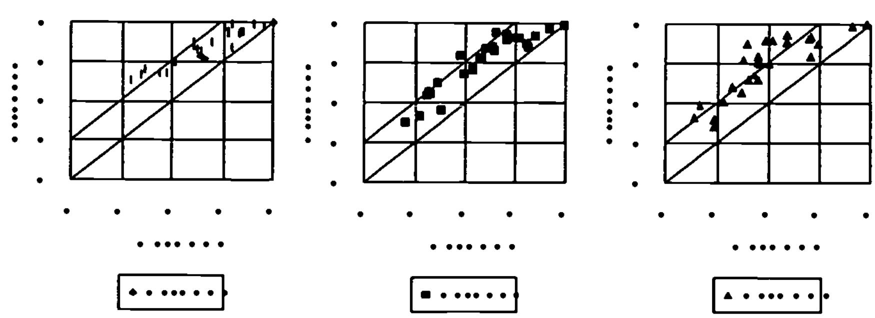


Figure 2 Scores of self-assessment

The total score and the scores of three questions (use of online dictionaries, OPAC search, and limiting line length of Mail body), which are similar in two exams, were considered in a two-way ANOVA. As a result, these four items showed an "interaction" between the two exams and classes ($p < 0.05$).

Figure 1 shows a comparison of the average scores of two examinations. It indicates the existence of the "ceiling effect", that is, the score difference between class A and other two classes decreased after the class reorganization.

As for spreadsheets, two sessions (which means 180 minutes) were assigned for class C, while one session was assigned for class A and B classes using self-learning web based text. But the scores were 8 points in class A and 5 points in class C. The score of writing HTML also supports this tendency. From this fact, it is proved that class A students had higher ability in computer operations than other two class students.

4.2.2 Analysis of self-assessment questionnaire

As for the 27 items that were included both mid-term and term end questionnaires, the average term end exam scores were higher than mid-term scores in all classes in 1998 and in 1999. In Figure 2, the x-axis shows the midterm score, the y-axis shows the term-end score, and each scatter point in the graph represents the score of one item. Two years analysis showed same tendency.

We took the exam timing (midterm or term-end) and the classes as the factors of the two-way analysis of variance (ANOVA). The following four items of the questionnaire shows that there is an "interaction" between the exam timing and the classes ($p < 0.05$).

- Creating a new folder (directory)
- Editing a word document
- Browsing web pages
- Searching web site

We conclude that class C students perceived they were as self-confident in these items as the students in the other two classes.

Though the exam scores are not significantly correlated with students' self-assessments, we consider the class reorganization was effective for slow learners class students, because it is important for them to have confidence in their computer operations.

5 Comparison of class reorganizations

There is another attempt to reorganize classes. The 180 students majoring in Letters chose one of three classes whose lecture policy are "intensive (class A)', "intermediate (class B)" and "slow and steady (class C)". Teachers expected that computer literate students might choose class A, and novice would choose class C.

To evaluate two class organizations, we discuss the term-end exam scores and result of self-assessment.

5.1 Comparison of the term-end exam score

The students in six classes were given an examination at the end of the term. The full marks of each question were ten points. The following five questions are common to all classes.

(a) Look a difficult Kanji word up in a Japanese online dictionary.
(b) Explain how to cancel a printing job.
(c) Find Yukio Mishima's book using online public access catalog of the university library.
(d) Explain why 2-byte special characters should be avoided in e-mails.
(e) Show URLs of the companies which sell cars on the web.

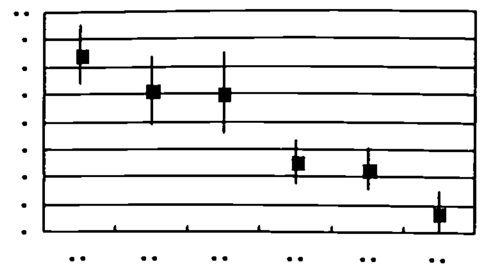
In Figure 3, the square(•) indicates the mean score of each class and the vertical line shows the 95% confidence interval of the mean score. To identify a particular class, we use H (for Human Sciences) and L (for Letters) as a subscript of the class name. For example, A_H denotes the "highest-score" class for students majoring in Human Sciences, C_L denotes the "slow-and-steady" class for students majoring in Letters.

The result of the "one-way ANOVA " and the "statistical multiple comparison" shows that questions (a), (b), (c) and (d) have statistical difference ($p<0.05$). Most of the confidence intervals of the class C are bigger than those of other classes, which means the variance of student competencies exists.
The score of the question (b) of "H" classes is higher than "L" classes. This might due to the fact that the operation was not taught in "L" classes.

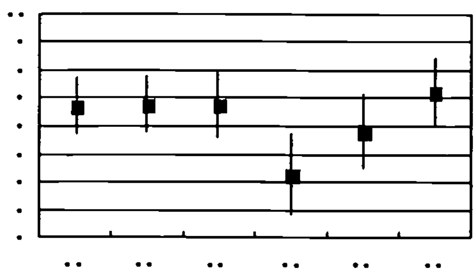
5.2 Comparison of exam score and result of the self-assessment

Before the term-end exam, the same questionnaire survey was also distributed to the L classes. Figure 4 shows the distribution of self-assessment score of two items: consulting on-line dictionaries and canceling a printing job. The "one-way ANOVA " and the "statistical multiple comparison" show that the differences of mean scores among classes were significant in the Figure 4 (a) but not significant in the Figure 4 (b).

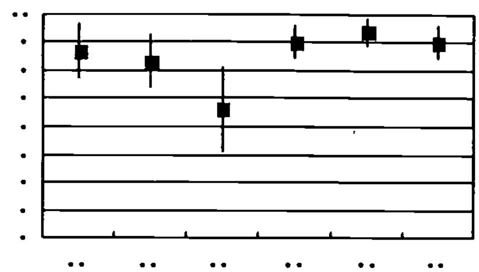
(a) Consulting on-line dictionaries



(b) Canceling a printing job

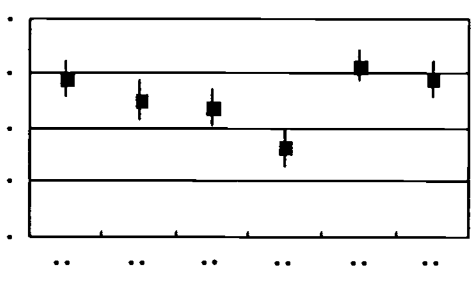


(c) Accessing on-line catalog of the library

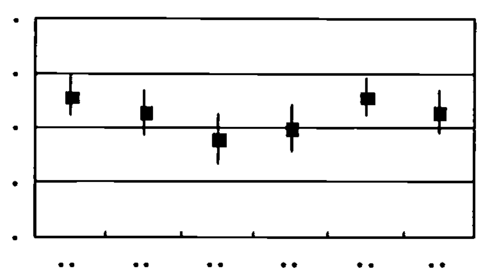


(d) Explaining special characters

Figure 3 Distribution of the term-end exam scores



(a) Consulting on-line dictionaries



(b) Canceling a printing job

Figure 4 Distribution of self-assessment scores

The comparison between the exam scores and self-assessment shows that all of students who achieved high mark in the exam don't necessarily perceive that they were very good at it. For example, although the scores are high in Figure 3 (a), the result of the self-assessment is not good.

6 Conclusions

In the first half of the paper, we described the effect of class reorganization in the middle of a term, which has enhanced learning outcomes in computer literacy classes. The class reorganization is also a good tool for teachers to know the way to lead students to higher skill level.

Figure 1 and Figure 2 suggest that many students, especially for those who belonged to class C, have made progress during the latter half of the semester. The progress was brought by the two factors, that is, the students' internal motivation and the class reorganization. Moreover, the "interaction effect" of the two factors must be taken into account as a factorial effect. In order to measure the effect of two factors separately, an experiment based on ANOVA model is necessary. However, the score improvement of class C suggests the existence of the class reorganization effect.

In 2000, we will incorporate group work, discussion and presentation for high ability students after the class reorganization.

References

[1] Gilster, P., "Digital literacy", John Wiley & Sons (1998).

[2] Higdon, J., "The evolution of computer literacy for preservice teachers", Proc. of 6th Int. Conf. of the Society for Information Technology and Teacher Education (1995).

[3] Keizer, J. and Wright, V., "Constructivism implementation in undergraduate computer application classes", Proc. of 8th Inf. Conf. of the Society for Information Technology and Teacher Education (1997).

[4] Mills, R., "Grouping students for instruction in middle schools", ERIC Digest, EDO-PS-98-4 (1998).

[5] Nakanishi, M. and Harada, A., "Reorganizing computer literacy classes in the middle of a term", Proc. of 7th Int. Conf. on Computers in Education, pp.507-514 (1999).

[6] Nakanishi, M. and Harada, A., "Ability grouping for teaching computer literacy classes", Proc. of ED-MEDIA, pp785-790 (2000).

[7] Raiford, P. and Braulick, L., "Computer literacy class for preservice teachers at university of Texas at Austin", Proc. of 6th Int. Conf. of the Society for Information Technology and Teacher Education (1995).

[8] Rogers, K.B., "The relationship of grouping practices to the education of the gifted and talented leaner", http://www.ucc.uconn.edu/~wwwgt/rogers.html (1999).

[9] Weinbrenner, S. and Devlin, B., "Cluster grouping of gifted students : How to provide full-time services on a part-time budget", http://www.kidsource.com/kidsource/content2/cluster-grouping.html (2000).

[10] Wiggins, G.P., "Assessing student performance: exploring the purpose and limits of testing", Jossey-Bass Publishers (1993).

Evaluation of the Web-Based Learning System "The Basic of Digital Media Communication "

Liu Huifen, Yu Lei, Liu Fang and Bao Su
Department of Communication, Tsinghua University, Beijing 100084,P.R.China
Tel: 86-10-62788647 Fax: 86-10-62785736
E-mail: liuhf@tsinghua.edu.cn

The web-based learning system "The Basic of Digital Media Communication" creates an interactive learning environment, which includes all the knowledge and aspects needed for the course. During the course, each student can choose freely either In Class Learning (ICL) or Web-Based Learning (WBL). Based on the questionnaires after the course, the paper evaluates the courseware system from the view of teaching and learning processes, interactive learning environments and learning effects. After the comparing study between ICL and WBL, it can be concluded that better computer and Internet environment can promote the students to accept the way of WBL, and WBL can enhance students' ability of self-study. Compared with ICL students, WBL students take less time and get higher score, and they are usually more efficient and individualized. The impact of traditional way of learning and interpersonal communication will exist for a long time, and there should be multi-way of learning to meet the different students.

Keywords: **Web-Based Learning, Evaluation, Interactive Learning Environments, Teaching and Learning Processes**

1 Introduction

The course, "The Basic of Digital Medial Communication", is a combination of computer application, communication and art design and it consists of basic theories, applications and creative design. That is, the basic knowledge of this course is about how to use the computer to organize, edit and deliver multimedia information. During the course, students need to do a lot of design works on computer. Because the content is so practical nowadays, the course is very popular among students. But since the course opened in 1996,it has confronted different problems concerning education mode and content. Firstly, the registration of the course is always limited by classroom and computer laboratory. Secondly, some of the reading materials were renewed and expanded nearly every year. Thirdly, because of the characteristics of the course, the most efficient way of learning and teaching is with the help of multimedia and network. Therefor, in the process of education reform, the course has experienced three ways of teaching and learning mode, that is, traditional learning, multimedia-assisted learning and Web-Based Learning. While improving the course gradually, a web-based courseware • The Basic of Digital Medial Communication• have been developed[1]. This courseware system constructs a comprehensive and interactive learning environment. The data capacity of the courseware is about 1 Gega Byte totally, and it includes all information and aspects needed for the course, such as the schedule, learning materials, experiment instruction, reference materials, demonstration and examples, answering questions, homework handed in and feedback, discussions and so on.

The object of the courseware is to construct a new learning mode, which should inspire the students' creativity and innovation. While instructed by teacher and assisted with modern education technologies, the students should be the center in the teaching and learning process. The course is carry on in an open and interactive environment, and the main features are as following:

(1) Open Computer Laboratories of the University are opened for the students, and they can visit the courseware at anywhere and on anytime if they logon to Internet. All the information about the course is published on the courseware, and the latest news or notice is always renewed according to teaching and learning process. The students can ask questions and discuss them with others through the courseware.

(2) According to the schedule, the students should finish a serial of media design work step by step. All the works can be handed in through web. Not long after hand in, each student can look up the web and get the score and comment from the teacher for each design work. The excellent works and the teacher' s comments will be published on the web on time, and the students can refer to and discuss about the works.
(3) In class lectures are based on the courseware, which will be projected on multimedia classroom. Discussing classes are arranged during the semester, which are also based on the courseware and projector. In this paper, we call this way of learning as In Class Learning (ICL).
(4) Except the ICL, the students can also choose the way of Web-Based Learning (WBL). In this way, the students need not attend the in class lectures, but they should finished all the design work and final test by self-leaning through the courseware system. The requirement of design work and final test are the same for both ICL and WBL students.

At first, the courseware system was used in a course composed of 30 students. Then, in the fall of 1999, it was used in a selective course opening to all the undergraduates and each student can freely choose the way of ICL or WBL, While the design work requirements and the test for both way are the same. At the end of the semester, two kinds of questionnaires were carried out among two group chose different learning modes. The questionnaires were designed in three aspects: the courseware system, the teaching and learning process and the learning effect. Compared and analyzed the feedback from the two groups, it can be concluded that, the web-based courseware system and learning mode have reached expected objects, and the learning effects have connection to the computer environment, the self-study ability of students and the impacts of traditional way of learning.

2 Web-Based Learning is the trend of modern education development

At the beginning of the semester, only 25% of the total 70 students chose the way of WBL. The others either chose ICL or couldn' t make their mind yet. After a period of time, when they got more familiar with the courseware system, all the students uncertain and 18% of those chose ICL originally turned to WBL. Consequently, the WBL students have made up of 61% of the total students registered. According to the investigation, the students' choice could be affected mainly by three factors, that is, self-study ability, computer and Internet environment and the basic knowledge for the course.

Among all the students, 72% of the juniors and seniors chose WBL, while only 46% of the freshmen and sophomores chose WBL. Those who chose the WBL consider it a better way, because the place, time and learning schedule can all been controlled freely by themselves. This in turn requires the students to be of higher ability of self-study. Most juniors and seniors prefer WBL, for they are usually better at self-study. From this point of view, higher ability of self-study is needed for WBL, and WBL will improve their ability of self-study, which is also the basic ability for life-long learning.

In order to visit the courseware without the limitation of time and space, Internet logon is the basic environment for the students. There are about 500 computers connected to Internet in the Open Laboratory of our University, but it' s always full of the students. More and more students have their own computers in dormitories, and more and more dormitories are connected to the Internet via high speed cable. From the investigation, most students chose WBL have better computer and Internet environment than those chose ICL. Therefor, the better the computer & Internet environment, the more the students who will accept WBL.

Because of the course' s feature, computer is both the tool and object of learning the course. Compared to ICL group, most WBL students consider they had basic idea about the course at the beginning of the semester. That means that WBL students have basic ability of computer application, which could been called as digital literacy and it' s the basic literacy demand in the information age [3]. So, the digital literacy is another factors that can affect their choices. In the process of WBL, computers and web are basic tools of learning, and it will definitely improve one' s ability for computer application or digital literacy.

3 Web-Based Learning is of more efficiency and individuality

WBL has more advantages over traditional way of learning. WBL has changed the traditional relationship between teacher and students, where the teacher is the initiative disseminator and the students are passive receivers. The courseware enables the students to study individually. They can decide how long to visit the courseware each time and which part to concentrate on. What' s more, they can do the homework or design work at the same time while reading the courseware, which is more efficient than traditional way of in class

BEST COPY AVAILABLE

lecture and then design work.

Take the learning procedure of one chapter in the course for an example. In the teaching schedule, 6 in class hours are planed to finish the chapter and the relative design work. Analyzing the percentage of students and the total hours used to finish this chapter' s learning and design work (Fig 1), the statistic result shows that the hours used by WBL students tend to be more changeable. The average hours used by WBL and ICL are 6.5 and 8 hours respectively, while the average scores of this design work are 77.7 and 79.8 respectively. That is, WBL group turns to be take less average time and get higher marks.

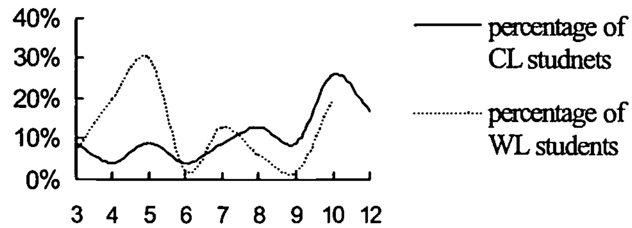


Fig 1: Percentage of students and the total hours used to learn chapter 7

Study the total time used for the course (Fig 2), it also shows that the ICL students tend to arrange their learning time according to teacher' s schedule, while WBL students tend to arrange their time individually. From the statistic of how WBL students read the courseware, only about 35% of them learn systematically and about 45% of them consult the courseware only if they need help. But WBL students' average total score is 84, higher than 80 of ICL students. Although scores are just one way to test the effect of learning, from all statistic results and analysis, it shows that WBL is of more efficiency and individuality.

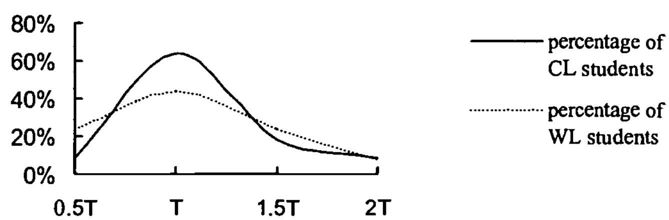


Fig 2: Percentage of students and the total time used for the course
(note: T is the total in class time of the course' s schedule)

4 The courseware system plays an important part in the learning process

The courseware is both the learning object and an effective learning tool, so it is very important in the learning process. At the beginning of the semester, teacher announces the schedule, homework requirement on the courseware. Then the Students can learn the knowledge from the courseware step by step according to the schedule, hand in their homework, ask questions and discuss relevant topics through the courseware. The answers to the common questions, the score and comment of everyone' s homework are also published on the courseware. The latest news on the courseware is renewed at least two times a week. Though parts of the learning materials are almost the same with the textbook, the courseware is more attractive because its multimedia, multiform and interaction.

The courseware is the main learning materials for the two groups, and more than one third of the students completed the learning only by the courseware. The top successful aspects of the course from the two group are showed in Table 1. When designing the courseware system, it was not expected that homework hand in and feedback by the courseware would be so popular among the students. The students whose excellent design work is published on the courseware are very proud about it, and the others would be greatly inspired and they will make their efforts to improve their own works too. So in the courseware, not only the database of learning material but also the interactive environment has played very important part in the teaching and learning process. Both WBL and ICL students evaluate the course highly, and the courseware system has reached its expected objects.

	ICL	WBL
1	Get the latest news from the courseware	Web-based learning
2	Homework hand in and feedback via the courseware	Homework hand in and feedback via the courseware
3	Discussing class by projector	Get the latest news from the courseware
4	In class lecture by projector	

Table 1: Statistic of the top successful aspects of the course

5 There should be multi-way of learning to meet the different students

At the end of the semester, most students feel satisfaction to the learning mode they chose, no matter WBL or ICL. Meanwhile, they all have good evaluations to self-study abilities. The two groups have different options about "discussing class". 68% of the ICL students think the discussion is indispensable and should be emphasized, for they can have chance to communicate with others in person, while 21% of the WBL students think it's unnecessary, for they can "discuss" in the courseware. It's clearly showed that, ICL students tend to be more rely on the interpersonal communication, while WBL students tend to be more rely on network communication. The weakening of interpersonal communication is a new problem emerging in the information age, and it will influence learning effect [4].

Analyzed which is "the best way of learning in college", 27% of all the students accept WBL completely, while 58% consider the best way is combining WBL and ICL, that is what we have done in the course. This kind of combination is suitable for students with different basis. For those tend to WBL, they can learn individually by the courseware system and consult the teacher in discussing class when they want. For those tend to ICL, they can get systematical instruction from the teacher in classroom, and use the courseware resource after class. In a long term, coexistence of multi-way of learning is a practical solution, which will instruct the learning and motivate creativity of students simultaneously.

6 Conclusion

Web-Based Learning has many advantages over traditional way, while it will take a long period of time for it to be perfected. Web-Based Learning has not only changed the teaching and learning process, but also the education mode and teaching thoughts. Its success depends on the network hardware, courseware and the efforts of the teacher and the students. In the course "The Basic of Digital Media Communication", the students are so eager for knowledge and so interesting in the educational reform. In fact, the courseware system is developed and improved during the teaching and learning process.

Web-Based Learning is the trend of education in today's information age. This kind of learning is different from completely self-study. Though the interactive learning environments of the courseware system, the teacher instructs the students how to learn, and encourages them to study independently. Although the content is professional, the structure and learning mode of the courseware system have common sense for other courses. In order to satisfy different students and enhance their ability as well, the in class lectures will be decreased gradually, but discussing classes will be remained both for interpersonal communication and for answering the question face to face. In order to cultivate the higher qualified students in the information age, the education mode should stress the ability of acquiring knowledge and self-learning. This in turn, requires the teacher to be higher qualified too.

References:

[1] Courseware system "basic of digital media communication"• http://166.111.107.2/digit-media/index.htm

[2] Liu Huifen & Wang Yue• "The Design and Development of Web-Based Interactive Learning Courseware in High Education", Proceeding of ICCE '99, Advanced Research In Computers and Communications in Education, Vol 2, 1999, Japan.

[3] Liu Huifen, Zhang Xing & Wang Yong• "Education Structure and Method Study for Computer Mediated Communication" Proceeding of ICCE '98 ,Global Education On the Net, Vol. 3, 1998• Beijing.

[4] Liu Huifen• "The Impact of interpersonal communication in Distance learning" ,Proceeding of GCCCEY2K, May, 2000 Singapore

Everything in Moderation? Developing successful collaborative projects between European initial teacher education students

David Owen *, Brian Hudson*, Alison Hudson, Eila Jeronen***, Jan Morawski****, and Peter Schurz*******

**Pedagogy and New Technologies Research Group*
School of Education
Sheffield Hallam University
Sheffield S10 2BP
United Kingdom
Tel: +44 144 225 2448
Fax: +44 114 225 2324
D.H.Owen@shu.ac.uk *and* B.G.Hudson@shu.ac.uk
*** Centre for Multimedia in Education*
Learning and Teaching Institute
Sheffield Hallam University
Sheffield S10 2BP
United Kingdom
A.R.Hudson@shu.ac.uk
****Department of Teacher Education*
University of Oulu
P.O.B. 222
90571 Oulu
Finland
ejeronen@ktk.oulu.fi
*****Department of Education and Social Studies*
Hogskolan Darlana
S-781 88 Falun
Sweden
jmo@du.se
******Pädagogische Akademie des Bundes in Oberösterreich*
Kaplanhofstrasse 40
A-4020 Linz
Austria
schuerz@pa-linz.ac.at

Computer mediated collaborative projects have the potential to strengthen the European Dimension in teacher education whilst giving students an appropriate context to develop their computing and collaborative skills. This paper evaluates the success of such a project through the completion of a three-year action research enquiry involving student teachers from four European countries. The results of three cycles of development are presented. The project was evaluated using student questionnaire data, participation in tutor meetings, and analysis of students' web page development and bulletin board contributions. Results suggest that successful collaborative project work depends on ease of access to reliable computer networks, giving equal weighting to resource production and levels of international communication, and effective moderation of the project by all tutors involved. The paper concludes by detailing future developments in European cooperation involving the partner institutions. These developments involve using the Ecoschool communication networks to discuss pedagogic and multi-media design issues involved in a cross-curricular CD-ROM which has been developed by the same group of partner institutions.

Keywords: **computer mediated communication, European co-operation, moderation.**

1 Introduction

This paper reviews a three-year cycle of telematics curriculum development and action-research in initial teacher education. The project has been made possible by funding via the SOCRATES European Module ECOSCHOOL (1997-2000). The project has two aims; to develop learning by using the World Wide Web (WWW) and email across Europe, and to learn about the social and economic aspects of the participant' s home city. The outcomes of the project include the creation of a collaborative open learning course that teacher education students can follow as part of their training.

The Ecoschool developments originated from European collaboration on the EUROLAND project (1996-99). It brings together partners from Austria, England, Finland and the Netherlands in building the European Dimension into the curriculum of schools and teacher education courses (Hudson et al, 1997 and Hudson et al, 1999). Teacher education institutions and departments lead both projects in close collaboration with partner schools and teachers in each country. The resources that have been produced by both the Ecoschool and Euroland projects have been used as the basis for the development of pedagogic approaches with teachers on intensive in-service training courses, which have been supported under the Comenius 3.2 Action of SOCRATES.

The paper reports on four aspects of the Ecoschool project; the three year cycle of curriculum development, the tutor and student evaluation of the project, lessons learned regarding telematics pedagogy, and future developments that link the outcomes of the Euroland and Ecoschool projects.

1.1 Participants in the project

The participants are primary teacher education students from Linz and Sheffield together with students on an international teacher education course at Oulu. A more recent partner to this development is the University of Darlana in Sweden. This has led to the participation of a group of social studies student teachers from Falun in Sweden. English was used as the medium for communication and a total of eighty five students took part over the three years.

1.2 Collaboration and communication

A key aim of the project has been to promote the European Dimension and the use of Information and Communications Technology (ICT) in teacher education across Europe. The development of the European Dimension provides ample justification for collaborative communication but such projects can also reflect sound pedagogic principles. The pedagogical approach is based on a socio-cultural communicative perspective, which owes much to the works of Vygotsky (1987). Collaborative learning is at the heart of the Ecoschool project and has been used during the three cycles of student work. Many authors, including Hudson (1998) and English and Yazdani (1999) see such an approach as essential in developing students' learning skills when using ICT or learning without the aid of new technology.

2 Use of new technologies

The resources and tools being used are university email communications and the resources provided by the ProTo environment at the University of Oulu – *Project Learning Tools on the Web.* This is an open learning environment that has been developed at the University of Oulu. Students can access the ProTo system via the World Wide Web. They have a password that allows them to create simple web pages and enter messages on a bulletin board. Students also created web pages using Netscape Composer and posted them on their home pages. In cycle three they used an electronic bulletin board as well as using ProTo and email.

Use of such technology is now a key focus in the education of teachers across Europe. Student teachers in England and Wales follow the National Curriculum for Initial Teacher Training (DfEE 1998). This curriculum requires students to show evidence of using and creating multi-media presentations, and of using web technologies to communicate with colleagues. In addition, recently published guidance detailing an ICT primary school curriculum (QCA, 1998), suggests that children aged ten should be able to design and evaluate simple multi-media presentations, and children aged eight should be able to take part in an email exchange. Clearly student teachers need the confidence and skills to develop these abilities in their pupils. The Ecoschool gives students this experience through their participation in a computer mediated collaborative project and by their evaluation of its potential use in their future educational roles.

2.1 Pedagogic approaches

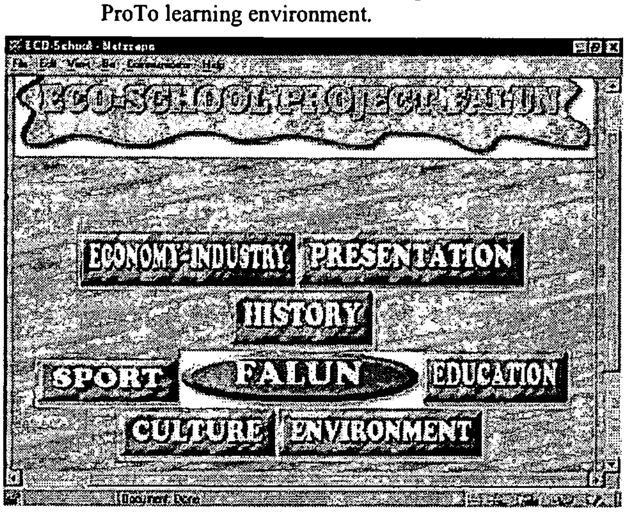
As previously stated the Ecoschool project uses a pedagogic approach that seeks to promote learning through 'electronic talk' in collaborative groups. These groups use a plan, do and review strategy as proposed by Kolb (1984) in his model of experiential education and by Schon (1987) describing the planning cycle used by reflective teachers and learners. The groups planned the construction of webpages, constructed and evaluated their own pages and those of other groups, then finally evaluated the whole project. Tutors developed their own pedagogy of distance learning during the project. The success of the tutors' approaches are analysed using guidance developed by McGee and Boyd (1995) to facilitate dialogue during computer mediated communication.

3 The three cycles of curriculum development

3.1 Cycle One

Focus : comparing students' home cities
Outcomes: web pages explaining local city

Figure 1: Work from the Swedish students posted to the ProTo learning environment.



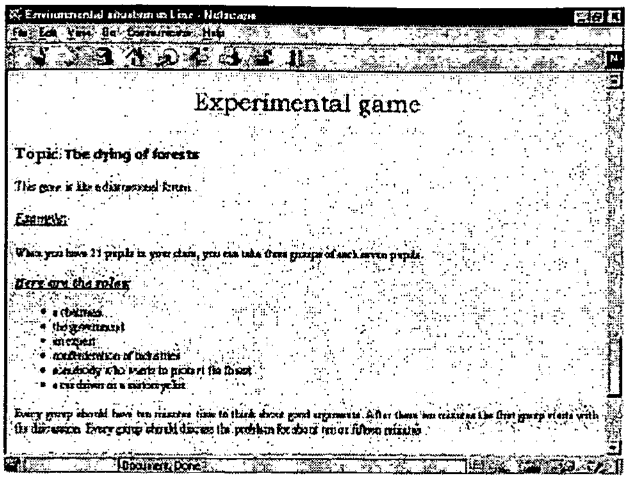
Students in each country worked in collaborative groups to produce a short illustrated report on one of the following aspects of their home city. This involved a general description of the city, an explanation of the environmental situation and the employment structure of the city, and an analysis of the regional or national education system.

Subsequently they presented these reports as web pages by writing them in to the ProTo learning environment. Figure 1 shows a page produced by the Swedish students. They also emailed their work to other students in the partner countries who were presenting the same topic. Once all web pages were complete, they read their partner's pages, asked questions and made comments about them on the bulletin board. Each group evaluated their work using the same criteria designed by the tutors in each country. The tutors then read each group's pages, assessed the pages and provided feedback to the each group. The students' work was assessed against the criteria and graded A to C. The tutors posted written feedback on the bulletin board.

3.2 Cycle Two

Focus : Comparing lesson planning
Outcomes: web pages giving examples of lesson plans

Figure 2: Teaching and learning about the environment in Lin

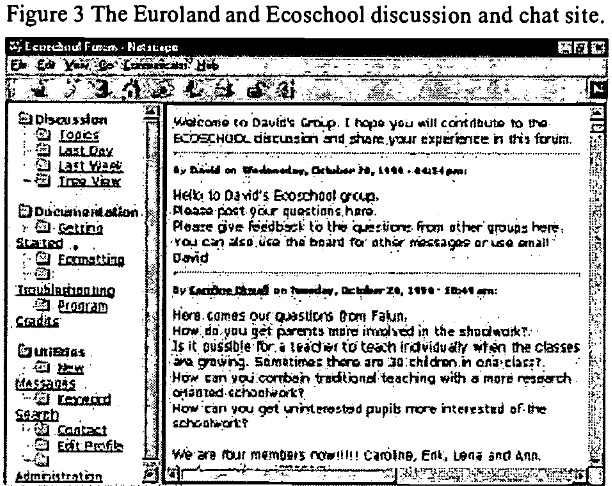


The aim of this round of co-operation was for students to share lesson plans and teaching ideas. Each group of students planned lessons with the aim of children learning more about their local town or city. Again, students presented these as web pages on the ProTo system or, in the case of the Swedish students, on their university home pages. Each group of students again evaluated the pages of their partner groups, responded to each other's questions, and received feedback from the tutors in each country. Students' work was again assessed.

3.3 Cycle Three

Focus: suggesting and solving educational problems
Outcomes: range of solutions to five educational problems

Figure 3 The Euroland and Ecoschool discussion and chat site.



The Ecoschool project ran during autumn 1999 with several new developments. The students were in internationally composed groups rather than from one single country and the focus of the project was to choose an educational problem and present a solution to this by co-operating using ICT. The students could use email, create their own web pages, use ProTo2 (a more sophisticated version), or use the Ecoschool bulletin board (see Figure 3). The majority of students chose to use the bulletin board to present their problem and solutions although some students did use the ProTo2 learning environment. Again tutors gave feedback to the students and responded to their questions although the work was not graded.

4 Methods of curriculum development and evaluation

Ecoschool developments have followed an action research model, as the aim of the project was to develop a successful curriculum for initial teacher education over the three years of the project. The Ecoschool curriculum was developed in face-to-face planning meetings and followed up by email communication between partners in Austria, Finland, Sweden and England. The results of student and tutor evaluation were fed into the curriculum planning at the end of each cycle. The following methods have been employed in gathering evaluation data:

Student evaluation questionnaire. All students completed a questionnaire by email or on paper. Many groups posted the results of their evaluation on the ProTo system or on the Ecoschool bulletin board. The questionnaire requested information on student expectations of the project, levels of interaction, the role of the tutor, use of new technology and ideas for the future.

Tutor evaluation. A tutor from each country completed a written evaluation of their experience at the end of each cycle and presented the document for discussion at the annual Ecoschool development meetings.

Web page analysis. The students created web pages of differing levels of complexity during cycles one and two. The web pages construction process is evaluated against the six components of infomedia literacy as proposed by Lee (1999, pp.147-149). These components are:
1. An understanding of the nature and functions of infomedia and their impact on individuals and society.
2. The development of critical thinking ability.
3. The skill of efficient searching and critical selection of information.
4. Knowledge of multi-media production using appropriate technology.
5. Aesthetic appreciation of hypertext, graphic design and visual images.
6. Social participation in influencing the development of infomedia technology.

ProTo communication log analysis. The record of tutor and student communication during cycles one and two was analysed using Boyd and McGee's (1995) guidance on facilitating dialogues using computer-mediated communication. They suggest that facilitators provide both technical and content-specific support; are responsible for regularly communicating with the group; communicate in ways that require a response; and model standards of high quality interaction

Ecoschool bulletin board observation. The Ecoschool bulletin board was set up in September 1999 and provided the student groups with a shared electronic space for presenting and discussing their ideas. Each group had a separate area for their own use. The frequency and quality of communication was analysed as well as the level of interaction between group members.

5 Evaluation Results

Student evaluation questionnaire data was collected from 12 of the 16 student groups over the three years. The key points arising were:
- In cycles one and two students who were apprehensive about using the technology felt that had been successful and the majority of students found that resource production was enjoyable and had developed their ICT skills.
- Communication between groups was successful in cycles one and two but sporadic in cycle three. This was attributed to pressure of work from other areas of their degree (Oulu), lack of clarity in terms of the aims of the project and technological problems in Linz and Sheffield.
- In cycle three, two of the five groups were critical of the lack of commitment of their partners.
- Students in Sheffield requested formal computer sessions where they could meet and use university facilities for the project. All students felt that their tutors had supported them in cycles one and two, but three groups wanted clearer guidance in cycle three.
- By cycle three the students from Falun and Oulu requested the use of chat and video conferencing technology in any future work. Individual students in Linz and Sheffield experienced technical difficulties during November 1999 due to network problems at their institutions.

Minutes of three *Tutor evaluation* meetings and five written reports state that:
- The role of the tutor was clear in cycles one and two but not in cycle three
- Cycle three was seen as a radical departure from previous work and was viewed as 'experimental'
- Students in Linz, Oulu and Sheffield were hampered by block teaching practices taking place during key times in the project.
- Tutors were pleased with the progress made by their students in cycles one and two and had discussed how work in cycle three could be improved.

Web page analysis using Lee's concept of infomedia literacy reveals:
- Only two groups took a critical approach to the sources they used when constructing pages about their

home city in cycle one.
- Three groups overtly discussed the problems of representing people and places on their web pages in cycle two.
- Four groups of students in cycle one saw the pages as similar to written text so did not exploit the advantages of hypertext fully.
- All students changed from passive users of web pages to active publishers of their own content.
- The students from Falun produced a website in cycle two that clearly demonstrated a collaborative approach and a high level of aesthetic appreciation in regard to page design.
- Students from Oulu and Falun were in general more adept at making critical comments about their own and other's work than the Linz and Sheffield students.

ProTo communication log and *Ecoschool bulletin board observation* using McGee and Young's guidance shows:
- In cycles one and two tutors adequately fulfilled the roles of moderator, mediator and facilitator.
- Tutors communicated with the participants by asking one or more questions, giving examples from their own experience to add to discussions and modelling high quality interaction.
- The cycle three work led to the production of questions and solutions but little discussion. In general tutors did not moderate the discussion effectively as they were unsure of their roles.
- The decision to limit the role of the tutor in cycle three had a negative effect on the level of interaction and quality of discussion. Student evaluations reveal uncertainty about technical issues as well as pleas for stronger leadership and rigid deadlines.

6 Discussion

The cycles of curriculum development and evaluation have identified many important features in the development of collaborative ICT projects. Establishing an international electronic community requires access to reliable technology for the students and also skill and commitment on the part of the tutors. Asynchronous communication is seen as one of the great advantages of electronic communication and university tutors may take their own ease of access for granted. In a study of barriers to student computer usage McMahon et al (1999) found that students identify real problems in accessing computers to complete course tasks. A Sheffield student reflects their conclusions when evaluating her experience in cycle three:

> *If we had been given time in our lectures to get together and a set routine with correspondence time every week then we would have got more out of it. As a group of people we are all in different (teaching) groups, so getting together is difficult and finding a PC when we have free time is also difficult.*

This highlights the question of computer access as well as the importance of study and group work skills in such a project. Very clear project goals and explicit expectations on student participation are also needed. Is it the students ' responsibility to meet and organise communication sessions during their own time, or will better levels of communication occur by booking computer access during student practical classes? If this is done are the benefits of asynchronous communication being demonstrated? An unexpected outcome of this project has been to highlight the importance of developing students' teamworking skills.

Once access is assured, the roles of the tutor as moderator, mediator and facilitator are crucial. A key finding from the evaluation is that communication was much more successful when the tutors had a strong moderating role in cycles one and two. When planning for cycle three, tutors limited the moderation role and gave the student groups much more independence. The majority of the students interpreted this as poor planning and one group described it as 'lack of leadership'. This highlights the complexity of the moderator's role and a recommendation from this project would be that the tutors spend time in the final evaluation meeting exploring their experiences in this role.

Developing a successful collaborative curriculum is dependent on creating a fine balance between resource production and communication. In cycle one the web pages produced were basic, but quality of interaction between students was high. In cycle two the web-based products were much more sophisticated but students paid less attention to communication, perhaps because more academic credit was gained for page development rather than communicating with fellow students. Student's work in the final cycle showed some evidence of sound international cooperation, but less in-depth critical analysis. Experiences gained during the three cycles have led to the development of a formal curriculum unit (see http://www.shu.ac.uk/schools/ed/teaching/dho/). Students will gain high grades only by giving equal weighting to communication, resource production and critical evaluation in their group work.

Finally, teacher education students need to transfer their learning to a classroom situation. One student has already set up a similar project whilst on teaching practice. In this example infant school children communicated via email with children in Bermuda and compared their localities, hobbies and homes as part of English and geography learning. Tutors need to set up opportunities for students to use their newfound confidence and skill in the classroom. Nook Lane Primary School in Sheffield is now linked with partner schools in Linz and Oulu as a result of the project, and students can now contribute to the development of this partnership.

6.1 Future developments

As a result of ongoing evaluation the following developments have been planned for 2000-2001. A chat facility had been added to the Euroland/Ecoschool discussion area in addition to the bulletin boards. Building on the success of a trial video-conferencing session held in November 1999, students will be able to use this form of communication from September 2000 in all countries. Students and teachers can also now access the communication tools via the Hallam Geography Education web site as well as from the Euroland web pages. Finally, with the imminent completion of the Euroland CD-ROM, the two projects will be brought together. Students and teachers will be able to use the CD-ROM as a focus for collaboration and discussion in the areas of infomedia literacy and multi-media development, the pedagogy of computer-mediated collaboration and the comparison of European social and environmental learning.

7 Conclusion

The Euroland and Ecoschool projects represent successful examples of how an international perspective can be developed in the university and school curricula. Sustained and effective communication is the key to such initiatives, alongside ease of access to computing facilities and a focus on the crucial role of the tutor as moderator. Both projects have provided tutors, students and pupils with membership of an expanding European network, which is a solid platform for the development of further collaborative work.

8 References

DfEE (1998) High Status: High Standards Circular 4/98. HMSO.

English, S and Yazdani, M. (1999) Computer-supported co-operative learning in a Virtual University. *Journal of Computer Assisted Learning*, 15, 2-13.

Hudson, B. (1998) A social perspective on learning in the context of Computer Mediated Communication in teacher education. *Proceedings of ICCE 98: International Conference on Computers in Education*, Beijing, China, 14-17 October 1998, 627 – 632.

Hudson, B., Hudson, A. & Schürz, P. (1997), Euroland: A Collaborative European Cross-Curricular Project using CD-ROM. *Proceedings of ICCE 97: International Conference on Computers in Education*, Kuching, Sarawak, Malaysia, December 1997, 1006-1007.

Hudson, B., Schürz, P. and Hudson, A. (1999), The Euroland/Ecoschool projects: Promoting Collaboration in a European context using CD-ROM and the WWW, Paper to Subnetwork D: Powerful Learning Environments in Teacher Education. *Conference of the Thematic Network on Teacher Education in Europe (TNTEE)*, Lisbon, 1999, http://tntee.umu.se/lisboa/

Kolb, D.A. (1984) *Experiential Education: Experience as the source of learning and development*. Prentice-Hall.

Lee, A.Y.L (1999) Infomedia Literacy: An educational basic for young people in the new information age. *Information, Communication and Society*, 2, 2, 134-155.

McGee, P.A. and Boyd, V (1995) *Computer-Mediated Communication: Facilitating Dialogues* at http://www.coe.uh.edu/insite/elec_pub/html1995/173.htm. Visited 4/10/00.

McMahon, J., Gardner J., Gray, C., and Mulhern. G. (1999) Barriers to student computer usage: staff and student perceptions. *Journal of Computer Assisted Learning*, 15, 302-311.

Schon, D.A. (1987) *Educating the Reflective Practitioner: towards a new design for teaching and learning in the professions*. Jossey-Bass.

QCA (1998) Information *and Communications Technology: A Scheme of Work for KS1 and KS2.* QCA.
Vygotsky, L.S. (1987) *The Collected Works of L.S. Vygotsky*, Vol.1 Plenum Press, NY.

http://www.shu.ac.uk/services/lc/cmeweb/Euroland/chatgroups.htm
The Euroland and Ecoschool discussion and chat fora.
http://ProTo.oulu.fi/
The ProTo open learning environment.
http://www.du.se/~lmh98lae/
Ecoschool pages created by students form Falun, Sweden.
http://wwwedu.oulu.fi/homepage/ejeronen/eco/index.htm
All cycle one and cycle two work can be viewed at this location.

Everything in Moderation? Developing successful collaborative projects between European initial teacher education students

David Owen *, Brian Hudson*, Alison Hudson, Eila Jeronen***, Jan Morawski****, and Peter Schurz*******

**Pedagogy and New Technologies Research Group*
School of Education
Sheffield Hallam University
Sheffield S10 2BP
United Kingdom
Tel: +44 144 225 2448
Fax: +44 114 225 2324
D.H.Owen@shu.ac.uk *and* B.G.Hudson@shu.ac.uk
*** Centre for Multimedia in Education*
Learning and Teaching Institute
Sheffield Hallam University
Sheffield S10 2BP
United Kingdom
A.R.Hudson@shu.ac.uk
****Department of Teacher Education*
University of Oulu
P.O.B. 222
90571 Oulu
Finland
ejeronen@ktk.oulu.fi
*****Department of Education and Social Studies*
Hogskolan Darlana
S-781 88 Falun
Sweden
jmo@du.se
******Pädagogische Akademie des Bundes in Oberösterreich*
Kaplanhofstrasse 40
A-4020 Linz
Austria
schuerz@pa-linz.ac.at

Computer mediated collaborative projects have the potential to strengthen the European Dimension in teacher education whilst giving students an appropriate context to develop their computing and collaborative skills. This paper evaluates the success of such a project through the completion of a three-year action research enquiry involving student teachers from four European countries. The results of three cycles of development are presented. The project was evaluated using student questionnaire data, participation in tutor meetings, and analysis of students' web page development and bulletin board contributions. Results suggest that successful collaborative project work depends on ease of access to reliable computer networks, giving equal weighting to resource production and levels of international communication, and effective moderation of the project by all tutors involved. The paper concludes by detailing future developments in European cooperation involving the partner institutions. These developments involve using the Ecoschool communication networks to discuss pedagogic and multi-media design issues involved in a cross-curricular CD-ROM which has been developed by the same group of partner institutions.

Keywords: **computer mediated communication, European co-operation, moderation.**

1 Introduction

This paper reviews a three-year cycle of telematics curriculum development and action-research in initial teacher education. The project has been made possible by funding via the SOCRATES European Module ECOSCHOOL (1997-2000). The project has two aims; to develop learning by using the World Wide Web (WWW) and email across Europe, and to learn about the social and economic aspects of the participant's home city. The outcomes of the project include the creation of a collaborative open learning course that teacher education students can follow as part of their training.

The Ecoschool developments originated from European collaboration on the EUROLAND project (1996-99). It brings together partners from Austria, England, Finland and the Netherlands in building the European Dimension into the curriculum of schools and teacher education courses (Hudson et al, 1997 and Hudson et al, 1999). Teacher education institutions and departments lead both projects in close collaboration with partner schools and teachers in each country. The resources that have been produced by both the Ecoschool and Euroland projects have been used as the basis for the development of pedagogic approaches with teachers on intensive in-service training courses, which have been supported under the Comenius 3.2 Action of SOCRATES.

The paper reports on four aspects of the Ecoschool project; the three year cycle of curriculum development, the tutor and student evaluation of the project, lessons learned regarding telematics pedagogy, and future developments that link the outcomes of the Euroland and Ecoschool projects.

1.1 Participants in the project

The participants are primary teacher education students from Linz and Sheffield together with students on an international teacher education course at Oulu. A more recent partner to this development is the University of Darlana in Sweden. This has led to the participation of a group of social studies student teachers from Falun in Sweden. English was used as the medium for communication and a total of eighty five students took part over the three years.

1.2 Collaboration and communication

A key aim of the project has been to promote the European Dimension and the use of Information and Communications Technology (ICT) in teacher education across Europe. The development of the European Dimension provides ample justification for collaborative communication but such projects can also reflect sound pedagogic principles. The pedagogical approach is based on a socio-cultural communicative perspective, which owes much to the works of Vygotsky (1987). Collaborative learning is at the heart of the Ecoschool project and has been used during the three cycles of student work. Many authors, including Hudson (1998) and English and Yazdani (1999) see such an approach as essential in developing students' learning skills when using ICT or learning without the aid of new technology.

2 Use of new technologies

The resources and tools being used are university email communications and the resources provided by the ProTo environment at the University of Oulu – *Project Learning Tools on the Web*. This is an open learning environment that has been developed at the University of Oulu. Students can access the ProTo system via the World Wide Web. They have a password that allows them to create simple web pages and enter messages on a bulletin board. Students also created web pages using Netscape Composer and posted them on their home pages. In cycle three they used an electronic bulletin board as well as using ProTo and email.

Use of such technology is now a key focus in the education of teachers across Europe. Student teachers in England and Wales follow the National Curriculum for Initial Teacher Training (DfEE 1998). This curriculum requires students to show evidence of using and creating multi-media presentations, and of using web technologies to communicate with colleagues. In addition, recently published guidance detailing an ICT primary school curriculum (QCA, 1998), suggests that children aged ten should be able to design and evaluate simple multi-media presentations, and children aged eight should be able to take part in an email exchange. Clearly student teachers need the confidence and skills to develop these abilities in their pupils. The Ecoschool gives students this experience through their participation in a computer mediated collaborative project and by their evaluation of its potential use in their future educational roles.

2.1 Pedagogic approaches

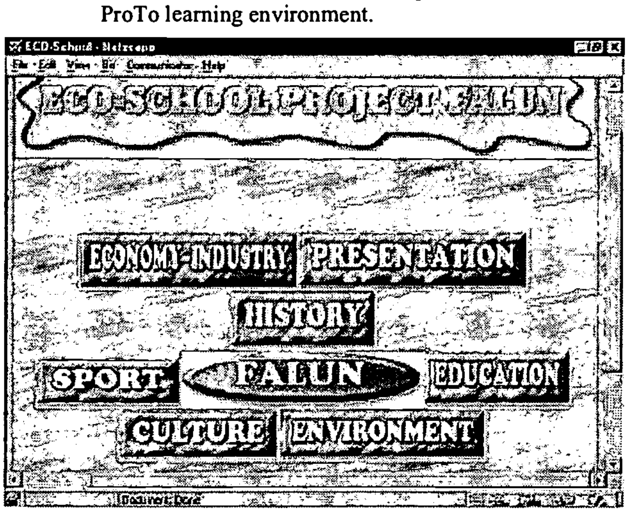
As previously stated the Ecoschool project uses a pedagogic approach that seeks to promote learning through 'electronic talk' in collaborative groups. These groups use a plan, do and review strategy as proposed by Kolb (1984) in his model of experiential education and by Schon (1987) describing the planning cycle used by reflective teachers and learners. The groups planned the construction of webpages, constructed and evaluated their own pages and those of other groups, then finally evaluated the whole project. Tutors developed their own pedagogy of distance learning during the project. The success of the tutors' approaches are analysed using guidance developed by McGee and Boyd (1995) to facilitate dialogue during computer mediated communication.

3 The three cycles of curriculum development

3.1 Cycle One

Focus : comparing students' home cities
Outcomes: web pages explaining local city

Figure 1: Work from the Swedish students posted to the ProTo learning environment.



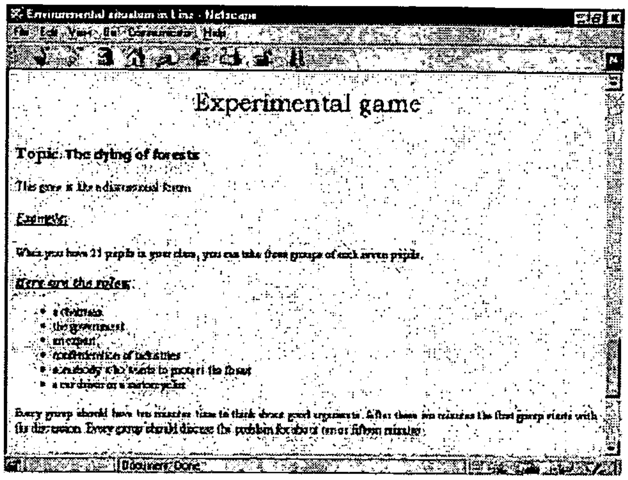
Students in each country worked in collaborative groups to produce a short illustrated report on one of the following aspects of their home city. This involved a general description of the city, an explanation of the environmental situation and the employment structure of the city, and an analysis of the regional or national education system.

Subsequently they presented these reports as web pages by writing them in to the ProTo learning environment. Figure 1 shows a page produced by the Swedish students. They also emailed their work to other students in the partner countries who were presenting the same topic. Once all web pages were complete, they read their partner's pages, asked questions and made comments about them on the bulletin board. Each group evaluated their work using the same criteria designed by the tutors in each country. The tutors then read each group's pages, assessed the pages and provided feedback to the each group. The students' work was assessed against the criteria and graded A to C. The tutors posted written feedback on the bulletin board.

3.2 Cycle Two

Focus : Comparing lesson planning
Outcomes: web pages giving examples of lesson plans

Figure 2: Teaching and learning about the environment in Lin

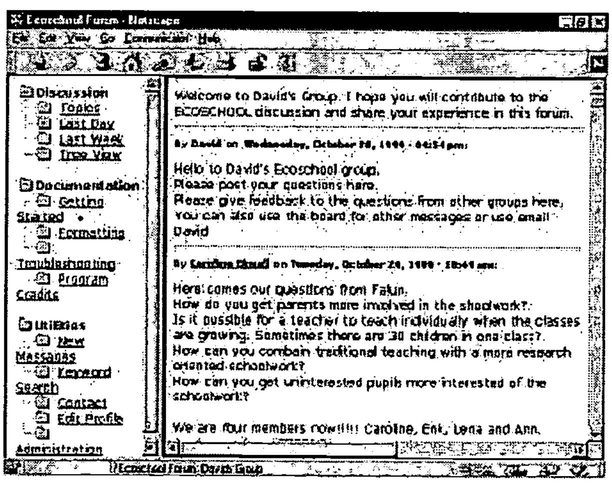


The aim of this round of co-operation was for students to share lesson plans and teaching ideas. Each group of students planned lessons with the aim of children learning more about their local town or city. Again, students presented these as web pages on the ProTo system or, in the case of the Swedish students, on their university home pages. Each group of students again evaluated the pages of their partner groups, responded to each other's questions, and received feedback from the tutors in each country. Students' work was again assessed.

3.3 Cycle Three

Focus: suggesting and solving educational problems
Outcomes: range of solutions to five educational problems

Figure 3 The Euroland and Ecoschool discussion and chat site.



The Ecoschool project ran during autumn 1999 with several new developments. The students were in internationally composed groups rather than from one single country and the focus of the project was to choose an educational problem and present a solution to this by co-operating using ICT. The students could use email, create their own web pages, use ProTo2 (a more sophisticated version), or use the Ecoschool bulletin board (see Figure 3). The majority of students chose to use the bulletin board to present their problem and solutions although some students did use the ProTo2 learning environment. Again tutors gave feedback to the students and responded to their questions although the work was not graded.

4 Methods of curriculum development and evaluation

Ecoschool developments have followed an action research model, as the aim of the project was to develop a successful curriculum for initial teacher education over the three years of the project. The Ecoschool curriculum was developed in face-to-face planning meetings and followed up by email communication between partners in Austria, Finland, Sweden and England. The results of student and tutor evaluation were fed into the curriculum planning at the end of each cycle. The following methods have been employed in gathering evaluation data:

Student evaluation questionnaire. All students completed a questionnaire by email or on paper. Many groups posted the results of their evaluation on the ProTo system or on the Ecoschool bulletin board. The questionnaire requested information on student expectations of the project, levels of interaction, the role of the tutor, use of new technology and ideas for the future.

Tutor evaluation. A tutor from each country completed a written evaluation of their experience at the end of each cycle and presented the document for discussion at the annual Ecoschool development meetings.

Web page analysis. The students created web pages of differing levels of complexity during cycles one and two. The web pages construction process is evaluated against the six components of infomedia literacy as proposed by Lee (1999, pp.147-149). These components are:

1. An understanding of the nature and functions of infomedia and their impact on individuals and society.
2. The development of critical thinking ability.
3. The skill of efficient searching and critical selection of information.
4. Knowledge of multi-media production using appropriate technology.
5. Aesthetic appreciation of hypertext, graphic design and visual images.
6. Social participation in influencing the development of infomedia technology.

ProTo communication log analysis. The record of tutor and student communication during cycles one and two was analysed using Boyd and McGee's (1995) guidance on facilitating dialogues using computer-mediated communication. They suggest that facilitators provide both technical and content-specific support; are responsible for regularly communicating with the group; communicate in ways that require a response; and model standards of high quality interaction

Ecoschool bulletin board observation. The Ecoschool bulletin board was set up in September 1999 and provided the student groups with a shared electronic space for presenting and discussing their ideas. Each group had a separate area for their own use. The frequency and quality of communication was analysed as well as the level of interaction between group members.

5 Evaluation Results

Student evaluation questionnaire data was collected from 12 of the 16 student groups over the three years. The key points arising were:

- In cycles one and two students who were apprehensive about using the technology felt that had been successful and the majority of students found that resource production was enjoyable and had developed their ICT skills.
- Communication between groups was successful in cycles one and two but sporadic in cycle three. This was attributed to pressure of work from other areas of their degree (Oulu), lack of clarity in terms of the aims of the project and technological problems in Linz and Sheffield.
- In cycle three, two of the five groups were critical of the lack of commitment of their partners.
- Students in Sheffield requested formal computer sessions where they could meet and use university facilities for the project. All students felt that their tutors had supported them in cycles one and two, but three groups wanted clearer guidance in cycle three.
- By cycle three the students from Falun and Oulu requested the use of chat and video conferencing technology in any future work. Individual students in Linz and Sheffield experienced technical difficulties during November 1999 due to network problems at their institutions.

Minutes of three *Tutor evaluation* meetings and five written reports state that:

- The role of the tutor was clear in cycles one and two but not in cycle three
- Cycle three was seen as a radical departure from previous work and was viewed as 'experimental'
- Students in Linz, Oulu and Sheffield were hampered by block teaching practices taking place during key times in the project.
- Tutors were pleased with the progress made by their students in cycles one and two and had discussed how work in cycle three could be improved.

Web page analysis using Lee's concept of infomedia literacy reveals:

- Only two groups took a critical approach to the sources they used when constructing pages about their home city in cycle one.

- Three groups overtly discussed the problems of representing people and places on their web pages in cycle two.
- Four groups of students in cycle one saw the pages as similar to written text so did not exploit the advantages of hypertext fully.
- All students changed from passive users of web pages to active publishers of their own content.
- The students from Falun produced a website in cycle two that clearly demonstrated a collaborative approach and a high level of aesthetic appreciation in regard to page design.
- Students from Oulu and Falun were in general more adept at making critical comments about their own and other's work than the Linz and Sheffield students.

ProTo communication log and *Ecoschool bulletin board observation* using McGee and Young's guidance shows:

- In cycles one and two tutors adequately fulfilled the roles of moderator, mediator and facilitator.
- Tutors communicated with the participants by asking one or more questions, giving examples from their own experience to add to discussions and modelling high quality interaction.
- The cycle three work led to the production of questions and solutions but little discussion. In general tutors did not moderate the discussion effectively as they were unsure of their roles.
- The decision to limit the role of the tutor in cycle three had a negative effect on the level of interaction and quality of discussion. Student evaluations reveal uncertainty about technical issues as well as pleas for stronger leadership and rigid deadlines.

6 Discussion

The cycles of curriculum development and evaluation have identified many important features in the development of collaborative ICT projects. Establishing an international electronic community requires access to reliable technology for the students and also skill and commitment on the part of the tutors. Asynchronous communication is seen as one of the great advantages of electronic communication and university tutors may take their own ease of access for granted. In a study of barriers to student computer usage McMahon et al (1999) found that students identify real problems in accessing computers to complete course tasks. A Sheffield student reflects their conclusions when evaluating her experience in cycle three:

> *If we had been given time in our lectures to get together and a set routine with correspondence time every week then we would have got more out of it. As a group of people we are all in different (teaching) groups, so getting together is difficult and finding a PC when we have free time is also difficult.*

This highlights the question of computer access as well as the importance of study and group work skills in such a project. Very clear project goals and explicit expectations on student participation are also needed. Is it the students ' responsibility to meet and organise communication sessions during their own time, or will better levels of communication occur by booking computer access during student practical classes? If this is done are the benefits of asynchronous communication being demonstrated? An unexpected outcome of this project has been to highlight the importance of developing students' teamworking skills.

Once access is assured, the roles of the tutor as moderator, mediator and facilitator are crucial. A key finding from the evaluation is that communication was much more successful when the tutors had a strong moderating role in cycles one and two. When planning for cycle three, tutors limited the moderation role and gave the student groups much more independence. The majority of the students interpreted this as poor planning and one group described it as 'lack of leadership'. This highlights the complexity of the moderator's role and a recommendation from this project would be that the tutors spend time in the final evaluation meeting exploring their experiences in this role.

Developing a successful collaborative curriculum is dependent on creating a fine balance between resource production and communication. In cycle one the web pages produced were basic, but quality of interaction between students was high. In cycle two the web-based products were much more sophisticated but students paid less attention to communication, perhaps because more academic credit was gained for page development rather than communicating with fellow students. Student's work in the final cycle showed some evidence of sound international cooperation, but less in-depth critical analysis. Experiences gained during the three cycles have led to the development of a formal curriculum unit (see http://www.shu.ac.uk/schools/ed/teaching/dho/). Students will gain high grades only by giving equal weighting to communication, resource production and critical evaluation in their group work.

Finally, teacher education students need to transfer their learning to a classroom situation. One student has already set up a similar project whilst on teaching practice. In this example infant school children communicated via email with children in Bermuda and compared their localities, hobbies and homes as part of English and geography learning. Tutors need to set up opportunities for students to use their newfound confidence and skill in the classroom. Nook Lane Primary School in Sheffield is now linked with partner schools in Linz and Oulu as a result of the project, and students can now contribute to the development of this partnership.

6.1 Future developments

As a result of ongoing evaluation the following developments have been planned for 2000-2001. A chat facility had been added to the Euroland/Ecoschool discussion area in addition to the bulletin boards. Building on the success of a trial video-conferencing session held in November 1999, students will be able to use this form of communication from September 2000 in all countries. Students and teachers can also now access the communication tools via the Hallam Geography Education web site as well as from the Euroland web pages. Finally, with the imminent completion of the Euroland CD-ROM, the two projects will be brought together. Students and teachers will be able to use the CD-ROM as a focus for collaboration and discussion in the areas of infomedia literacy and multi-media development, the pedagogy of computer-mediated collaboration and the comparison of European social and environmental learning.

7 Conclusion

The Euroland and Ecoschool projects represent successful examples of how an international perspective can be developed in the university and school curricula. Sustained and effective communication is the key to such initiatives, alongside ease of access to computing facilities and a focus on the crucial role of the tutor as moderator. Both projects have provided tutors, students and pupils with membership of an expanding European network, which is a solid platform for the development of further collaborative work.

8 References

DfEE (1998) High Status: High Standards Circular 4/98. HMSO.

English, S and Yazdani, M. (1999) Computer-supported co-operative learning in a Virtual University. *Journal of Computer Assisted Learning*, 15, 2-13.

Hudson, B. (1998) A social perspective on learning in the context of Computer Mediated Communication in teacher education. *Proceedings of ICCE 98: International Conference on Computers in Education*, Beijing, China, 14-17 October 1998, 627 – 632.

Hudson, B., Hudson, A. & Schürz, P. (1997), Euroland: A Collaborative European Cross-Curricular Project using CD-ROM. *Proceedings of ICCE 97: International Conference on Computers in Education*, Kuching, Sarawak, Malaysia, December 1997, 1006-1007.

Hudson, B., Schürz, P. and Hudson, A. (1999), The Euroland/Ecoschool projects: Promoting Collaboration in a European context using CD-ROM and the WWW, Paper to Subnetwork D: Powerful Learning Environments in Teacher Education. *Conference of the Thematic Network on Teacher Education in Europe (TNTEE)*, Lisbon, 1999, http://tntee.umu.se/lisboa/

Kolb, D.A. (1984) *Experiential Education: Experience as the source of learning and development*. Prentice-Hall.

Lee, A.Y.L (1999) Infomedia Literacy: An educational basic for young people in the new information age. *Information, Communication and Society*, 2, 2, 134-155.

McGee, P.A. and Boyd, V (1995) *Computer-Mediated Communication: Facilitating Dialogues* at http://www.coe.uh.edu/insite/elec_pub/html1995/173.htm. Visited 4/10/00.

McMahon, J., Gardner J., Gray, C., and Mulhern. G. (1999) Barriers to student computer usage: staff and student perceptions. *Journal of Computer Assisted Learning*, 15, 302-311.

Schon, D.A. (1987) *Educating the Reflective Practitioner: towards a new design for teaching and learning in the professions.* Jossey-Bass.

QCA (1998) Information *and Communications Technology: A Scheme of Work for KS1 and KS2*. QCA.
Vygotsky, L.S. (1987) *The Collected Works of L.S. Vygotsky*, Vol.1 Plenum Press, NY.

http://www.shu.ac.uk/services/lc/cmeweb/Euroland/chatgroups.htm
The Euroland and Ecoschool discussion and chat fora.
http://ProTo.oulu.fi/
The ProTo open learning environment.
http://www.du.se/~lmh98lae/
Ecoschool pages created by students form Falun, Sweden.
http://wwwedu.oulu.fi/homepage/ejeronen/eco/index.htm
All cycle one and cycle two work can be viewed at this location.

Explorers or Persisters? Evaluating Children Interacting, Collaborating and Learning with Computers

ROSEMARY LUCKIN AND BENEDICT DU BOULAY,
School of Cognitive & Computing Sciences
University of Sussex
Brighton BN1 9QH UK.
E-mail: *rosel@cogs.susx.ac.uk* and *bend@cogs.susx.ac.uk.*

In this paper we discuss our observations of a group of 10 and 11 year old children using an Interactive Learning Environment called the Ecolab. The design of this software was informed by our interpretation of Vygotsky s Zone of Proximal Development in which *Interaction* and *Collaboration* are definitive characteristics. The relationship between the differences in interaction/collaboration style and the learning gains made by the children are discussed. The results show that children can be grouped into profiles according to the differences and similarities in their use of the system and that common interaction features are influenced by the design of the software being used. We suggest that children are poor at managing their own learning experience with technology even when the software offers both opportunities to complete challenging activities and support to ensure success. The children in this study needed explicit direction towards activities which were beyond their ability. However, caution with regard to this provision of *direction* is important to ensure that the child is also offered opportunities for creativity: a suggestion from the system about what and how to proceed is often sufficient.

Keywords: **Interaction, Collaboration, ZPD, ILE.**

1 Introduction

Computers are now an accepted part of classroom life for most young learners whether they are used for communication, visualization, simulation experience or simply for fun. But how do children actually interact with computers? Does the nature of their interactions vary from child to child in a way that could inform the design of the software which engenders these interactions? This paper explores children s use of an Interactive Learning Environment (ILE) called the Ecolab which was designed to help children learn about ecology. The system attempts to fulfill the role of a more able learning partner for the child and invites collaborative interaction. The collaboration is thus between the system and the child and not between children. Here we describe the nature of the interactions that a class of children had with this system. The nature of these interactions is considered in the light of pre- and post-test learning gains to explore the relationship between learning and interaction style. The Ecolab software has been designed using a framework derived from our interpretations of the Zone of Proximal Development (ZPD) [10, 11]. The ZPD describes the most fertile interactions which occur between the more and less able members of an educational culture and focuses attention on how the more able can help learners to learn. The ZPD offers a theory of instruction which emphasizes the inseparability of the teaching and learning processes and thus recognizes the inherent interactivity of children s learning with computer software. It also stresses the need for learners to have the help of a collaborative learning partner in the form of a peer, a teacher or in the case of the Ecolab, a computer. Within a Vygotskian, socio-cultural model of education human activity is mediated by tools and sign systems that have arisen through social interaction. Developmental explanations are used to address the complex internalisation process by which the interpsychological relations between partners in social interaction becomes intrapsychological

BEST COPY AVAILABLE

within the individual learner. Interaction and Collaboration are therefore definitive characteristics of the ZPD which form the linchpin of the socio-cultural framework and thus form the focus of our investigations of children using the software.

In this paper we provide a brief description of the Ecolab software before discussing an evaluation study of its use. We report the results with particular emphasis upon the nature of the Interaction and Collaboration profiles we were able to construct from our records of system use. We provide examples of individual learner s use of the system and discuss the relationship between the nature of the interactions and the learning gains recorded after system use.

2 Ecolab Software

Ecology is a subject that involves the study of relationships between organisms within our environment. These relationships can be extremely complex; they can also be introduced in a simplified manner through concepts such as food chains and food webs. These form the foundations of more complex ecosystems and are part of the curriculum for primary school children in the United Kingdom. The Ecolab software provides 10 and 11 year old children with the facilities to build, activate and observe the ecological relationships which exist between members of a simple food web in a woodland ecosystem. It provides a simulated ecology laboratory environment into which the child places the animals and plants of her choice. This environment can be viewed by the child from several different perspectives or *views*, including:

World - a picture of a woodland environment and the organisms the child has chosen to place within it.
Web - a traditional text book style diagram of the organisms in a food chain and food web.
Energy - a graphical representation of the energy levels of the organisms currently alive in the Ecolab.
History - a linear narrative of what has happened in the Ecolab world to date, which animal has eaten which other animal for example.

As we have already stated the nature of the relationships that can exist between organisms in the real world can be very complex. We wished to allow each of the children using our system to learn about relationships at a level of complexity that was appropriate to them. We therefore built the learning environment in a manner that would allow children to learn about relationships ranging from the simplest, between just two single organisms, to the much more complex network of relationships that could exist in a very simple ecosystem involving populations of organisms. The complexity of the relationships represented within the Ecolab can be varied at any stage during the child's interaction with it. It is also possible to alter the abstractness of the terminology used to describe the organisms in the Ecolab so that a snail, for example, can be described by the words "herbivore", "primary consumer", or "consumer" as well as the word "snail".

In addition to this simulated laboratory environment, the system acts as a collaborative learning partner for each learner which can provide assistance of the following sorts:

Extension of the learner s knowledge through increasing the complexity of the relationships she is asked to study and/or the abstractness of the terminology used to describe what is happening in the Ecolab.

Collaborative Support which can take the shape of *Activity Differentiation:* in the form of alterations to the difficulty of the activities the learner is asked to complete, or context sensitive *Help* of variable levels of quality and quantity.

At the start of this paper we discussed our use of the Zone of Proximal Development to underpin our system design and the importance of *Interaction* and *Collaboration*. In order to explore the nature of the interactions children had with our software, the collaboration that might occur between system and learner, and the relationship between interaction, collaboration and the changes in learning outcome recorded after system use, we varied the manner in which collaboration from the system was offered to the learner. The Ecolab consists of three system variations: VIS (Vygotskian Inspired System), WIS (Woodsian Inspired System) and NIS (Non-theoretically Inspired System). These three system manipulations implement different design elements in order to adjust the assistance they provide (see [4] and [5] for more detail). The way in which each of the system variations adopts a different approach is summarised in Table 1. In particular, VIS makes more decisions than WIS which makes more decisions than NIS. In other words NIS gives the learner most freedom of choice to the learner and VIS the least.

3 Interactions with the Ecolab

An exploratory evaluation of the Ecolab software was conducted with a class of children aged 10 and 11 years. We wanted to investigate the extent to which the system would be able to adjust to learners of differing abilities, and also the ways in which the interactions and collaborations between user and system varied with users of different abilities. The children's school assessments were therefore used to allocate each child to one of three ability grouping: High, Average and Low. Prior to using the software each child completed a written and a verbal pre-test, the latter of which was in the form of a structured interview recorded on audio tape. Each child used the Ecolab software as an individual for a total of 60 minutes over two sessions. In addition, a 20 minute initial session with a smaller 'demo' versionensured that all children were comfortable with the mouse skills required and the interface. After the system intervention subjects were given a written and verbal test, identical to the pre-test, and a short additional extension interview. A delayed post-test was conducted 10 weeks after the end of the original post-test. Of the 30 children who started the study only 26 completed all sessions between, and including, pre and post-test. The four who did not complete these sessions had either left the school or been absent during the evaluation period. Only 24 completed all sessions including the delayed post-test. Once again the reason for non-completion was absence from school.

Table 1 Collaborative Support within Ecolab

Collaborative Support within Ecolab			
	VIS	WIS	NIS
Levels of Help Available (different levels provide differing qualities of help - 5 represents the greatest and 1 the least)	5	5	2
Decision about Level of Help made by	system	system and child	child
Levels of *Activity Differentiation* Available	3	3	3
Decision about type of Activity and Differentiation level made by	system	child - system makes suggestions	child
Extent of Learner Model maintained by the system and used to make decisions about the support.to be offered to the learner.	Bayesian Belief Network (BBN) of values representing the system's beliefs about child's ZPD formed from its knowledge about the amount of collaborative support used to date.	Record of help used to enable contingent calculation of next help level. Record of curriculum nodes visited maintained to permit suggestions.	Record of Curriculum nodes visited maintained to help child keep track.
Abstractness of Terminology selected by	system	child	child
Area of the Curriculum and complexity of the next activity selected by	system	child - system makes suggestions	child
Ecolab View selected by	mostly child	child	child

The results of the pre- and post-test were used to assess the efficacy of the three variations of the Ecolab software. This work is reported elsewhere [4, 5] and is not the main focus of the current paper. It is the character of the interactions between each child and the system that we will focus upon here. We wanted to investigate what sorts of interactions had resulted in the greater learning gains and which systems had supported and encouraged various types of interaction and collaboration in order to inform the design of our next system. For each child a summary record of their interactions was produced from the detailed logs maintained during their two sessions of system use and this was used to build up a picture of the types of interactions each child experienced with the system (for full information see [4]).

Cognitive or learning styles have been a subject of active interest in recent years [1, 3, 6, 8], for a brief review see [9]. The influence which a learner's style can have upon the way they interact with technology has also been recognised [7]. Within this literature there are examples of classification systems which differentiate learners according to their learning preferences; for example, as serialists or holists [6]. The analysis of the annotated interaction summaries of children's experiences with the Ecolab software takes a fresh perspective on classification using only the styles of interaction or *Profiles* which can be found in the records of each child's system use and emphasizing our interest in the nature of *Interaction* and *Collaboration*. Characteristics were identified and children categorised through:

- **Interaction Profiles** according to the character of their interactions with the Ecolab.
- **Collaboration Profiles** according to the nature of the collaborative support provided by the system for the child.

4 Results

One aspect of the evaluation looked at whether the different variations of the Ecolab had been more or less effective in increasing the child's learning gain in terms of her understanding of the feeding relationships which exist in a food web as reflected in the pre- and post-test data. This indicated that the system variation (VIS, WIS or NIS) which the child used was relevant to her subsequent learning gain and a detailed discussion of these results can be found in [5]. Here we wish to concentrate upon the analysis of the records of interaction which was used to try and pinpoint the elements of VIS and WIS which led to their superior performance with particular ability groups.

4.1 Interaction profiles.

There were two characteristics which could clearly be seen as either present, or largely absent within the children s interactions. These were referred to as:

- **Busyness** and
- **Exploration**

Busyness was considered to be a characteristic of interactions in which the children completed an average or above average number of actions of any type, such as adding an organism to their Ecolab world or making one organism eat another. The interaction summaries of these children contained an above average number of events. The opposite of Busyness is referred to as **Quietness**.

Exploration was considered to be a characteristic of an interaction if the child had been involved in some sort of action which allowed her to experience more than one level of complexity or more than one level of terminology abstraction, beyond her initial starting levels. The opposite of Exploration is referred to as **Consolidation**.

Some children also switched frequently from one type of interaction to another. For example, they might switch from attempting to make one animal eat another, to looking at their organisms in a different view (i.e. perspective), to accessing a new activity entirely. Their interactions contained no or few series of repeated actions of the same type. They were particularly prone to frequent changes of view. These users have been characterised as **hoppers**. Other learners exhibited a more persistent approach, with sets of actions of a similar type grouped together. These users have been referred to as **persisters**.

These characteristics allow the children to be categorised, in principle, into 1 of 8 (2x2x2) possible Interaction Profiles.

The three parameters of categorisation: Busy/Quiet, Exploration/Consolidation and Hopper/Persister bear some similarity to features found in other categorisation systems. Pask's [6] differentiation of tendencies in learners towards being either "top-down" holists or being "bottom-up" serialists shares some common ground with the Hopper/Persister characteristic, for example. The differentiation of exploration from continuing activity at a level of consolidation is likewise similar to the challenge/safety division of [2]. However, the motivation for the analysis reported in this paper was not the presentation of a generally applicable categorisation system. The aim was twofold:

- To investigate the relationship between interaction style and learning gain.
- To examine how each of the system variations (VIS, WIS and NIS) of the Ecolab supported and encouraged particular learning styles.

Children fell into 6 of the 8 possible Interaction Profile groups. The distribution within these groups is illustrated in Table 2.

Table 2 Interaction Profile Membership

Profile Description	% of children in Profile group
Busy - Exploring - Persister (BEP)	28%
Busy - Exploring - Hopper (BEH)	12%
Busy - Consolidating - Persister (BCP)	8%
Busy - Consolidating - Hopper (BCH)	12%
Quiet - Consolidating - Persister (QCP)	20%
Quiet - Exploring - Persister (QEP)	20%

4.1.1 Examples of User Interaction Profiles

S10 (Gene) was a typical example of the *Busy - Exploring - Persister* style of interacter. Her first action was to switch from world view to energy view and then back to world view. She then added 15 organisms to the Ecolab and visited energy view again. Upon switching back to world view she made one of her organisms eat another, switching to energy view to see the effect. This pattern of making organisms act, either eating or moving and looking at the effect in an increasing number of different views continued. Introductory, investigative and rule-definition activity types were completed for the first two nodes in the curriculum before her first session drew to a close. She chose not to save her current Ecolab world which meant that at the start of her next session her first actions were the addition of organisms. Once again she added all 15 and then moved into the next phase of food web complexity and used more abstract terminology to view her organisms. Whilst the nature of the actions she completed was now more advanced and several instances of help were used, her pattern of activity remained one of initiating an action or actions appropriate to the evident goal. Actions were often completed in pairs and were followed by viewing the result from different perspectives (most commonly, energy, web and world). She did not experiment with writing a program or attempt to escape from completing the activities offered to her.

This profile group contains only high and average ability children from the VIS and WIS system user groups. In terms of performance at post-test there was a tremendous spread: A *Busy - Exploring - Persister* style learner attained the lowest learning gain, another, the second highest learning gain. The high ability children within the group all achieved an above average learning gain, but within the average ability children there was a wider spread of learning gain scores. Membership of this group was limited to VIS and WIS users, of whom the VIS users all achieved above average post-test learning gains, including the highest learning gain within this user group.

4.2 Collaboration profiles.

Two characteristics were found to be the most useful for differentiating collaborative style within the interactions: Amount of support and Depth of support used. These collaboration characteristics were used to group the children into one of four Collaboration Profile groups.

Amount of support: the average amount of activity differentiation (i.e. the degree to which the activity is presented in a simpler form) and the average number of help instances for the experimental group was calculated. An above average amount of either activity differentiation or instances of help was the criteria necessary for a child to be considered as using 'Lots' of collaborative support.

Depth of support: this characteristic was based upon the level of help and level of differentiation used. Once again the average levels used within the experimental group were calculated. Help or differentiation above the average level resulted in a child being considered as using 'Deep' or higher level support.

Interactions could be grouped into all 4 of the possible Collaboration Profiles. The first group was the largest and was further divided in accordance with the type of support which was most prevalent. The distribution of children into these groups is illustrated in Table 3.

Table 3 Distribution of children within Collaboration Profile groups

Profile Description	% of children in Profile	Profile sub-group Description	% of children in Profile sub-group
Lots and Deep (LD)	53%	Differentiation and Help	19%
		Differentiation	19%
		Help	15%
Lots and Shallow (LND)	12%		
Little and Deep (NLD)	16%		
Little and Shallow (NLND)	19%		

4.2.1 Examples of User Collaboration Profiles

S1 (Jason's) use of the available support was typical of the *Lots and Deep* profile group and of a user of above average amounts of both help and activity differentiation. He used level 4 help early in his first session of system use to achieve success in making organisms eat each other. His initial activities were completed with maximum differentiation of level 3. This was gradually reduced and then increased again. During his first session of system use he completed a range of activities for three nodes in the first phase of the curriculum. All instances of successful help were at level 4 or level 5. Fewer activities were completed during his second session. However, these activities were at a lower level of differentiation and there were fewer instances of help.

This Collaboration Profile group was the largest and was subdivided to account for the type of support used. Only VIS and WIS system users shared the profile. Jason was a member of the subgroup which used above average amounts and levels of both activity differentiation and help. This subgroup again consisted only of high and average ability children whose mean learning gain is above the average for the whole class (16% as compared to the class average of 11.5%). The subgroup of children who used greater levels of differentiation than help contained children from all ability groups. This second subgroup also produced above average learning gains at post-test (18% as compared to the class average of 11.5%). The last subgroup of children, who used greater amounts of help than differentiation, were all average ability children. Their average learning gain was well below the class average (3.9% as compared to the class average of 11.5%).

System variation had a greater impact upon the nature of the Interaction and Collaboration profiles than ability. A Pearson Chi-squared statistical test was also used to assess the relationship between the Ability groups, System Variation Groups, Interaction Profile Groups and the Collaboration Profile Groups. There was a significant association between System variation membership and Collaboration Profile membership ($X^2 = 28.52$, df = 6, $p < .0001$), and also between System variation membership and Interaction Profile membership ($X^2 = 25.79$, df = 10, $p < .01$).

So far little has been said about the NIS user group, they have not belonged to either of the Profiles used in the examples. In fact, all the NIS users belonged to a Consolidating Interaction profile; there were no explorers in this system user group. In addition, and as has previously been mentioned, no NIS users were in the Lots and Deep Collaboration profile group.

S9's (Tim's) Interaction profile which was that of a Quiet, Consolidating Persister, was typicalof a NIS system user. His initial session consisted of adding a single snail and then making 11 view changes to look at this organism from all perspectives. This initial stage was followed by a series of organism additions (commonly in blocks of 4); single actions, such as move or eat commands, in blocks of 1 to 5; and view changes which were almost always in pairs. In session 2 he adopted the commonly seen approach of adding a considerable number of organisms to start (in this case 12) and then once again completing single actions and view changes.

BEST COPY AVAILABLE

Likewise S26 (Karlie) s Collaboration profile reflecting low use of all types of help (Little and Shallow: NLND) was typical. She placed herself at the far extreme of food web complexity and started dealing with populations of organisms straight away. She only completed one type of action during both sessions of computer use: she built food webs using the *build web* command. Initially she made errors and used only occasional low level feedback, persisting until successful. The children in this profile group were all of high or average ability, but their average learning gains were well below average (5.2% as compared to the class average of 11.5%)

A further difference found within the NIS user group relates to the relationship between ability and learning gain. In the VIS and WIS user groups it was the higher ability children who achieved the greatest learning gains. By contrast, amongst the NIS users none of the high ability children made an above average learning gain, in fact the only learners who made above average learning gains were the low ability children. Whilst the numbers are small and the study exploratory this result is interesting and is certainly informing our current research. We had expected that of all three systems, the one which left most control within the hands of the learner would be most effective with the more able learners. Our results indicate that the opposite was in fact the case in our study.

5 Conclusions

This is an initial exploratory study with small numbers of children. However, there are several observations which are informative in building up a picture of the sorts of interactions which children experienced with the version of the system they used. VIS was the system which explicitly selected the next curriculum area for the child to complete and controlled the complexity and abstractness of the learning environment. Not surprisingly, all VIS users were members of profile groups with the 'Exploring' characteristic present. The split between 'Busy' and 'Quiet' was almost even. Only two of the VIS users scored a below average learning gain at post-test and both were in the same 'Quiet, Exploring, Persister' profile group. The majority of WIS users were also 'Exploring' profile group members and only one did not belong to a 'Busy' profile group. However, whilst all the WIS above average learning gain achievers were members of 'Exploring' profile groups, the below average achievers were all members of different profile groups, with no common features between all of them. The WIS system variation did not set the curriculum area for the users, but did make suggestions which resulted in it being easier for a WIS user to avoid being an 'Explorer' than a VIS user. The NIS users were the children with the greatest freedom and the least finely tuned help system. It is perhaps not surprising therefore that none of them belonged to a profile group with the 'Exploring' characteristic. They were evenly split between being 'Busy' and 'Quiet' and the majority were 'Persisters'. Only two NIS users achieved above average learning gains and unlike the WIS and VIS users, both were in profile groups which shared the 'Comfortable' characteristic, they were also both in the low ability group.

These results suggest that simply providing children with the means for extension through becoming involved in challenging activities is not enough to ensure that these challenging activities are undertaken. The child needs also to be explicitly directed towards activities which are beyond her ability. However, caution with regard to this provision of *direction* is important to ensure that the child is also offered opportunities for creativity. The success of WIS indicates that a suggestion about what and how to proceed is often sufficient. The consistency within the high and average ability groups across the different systems for above average learning gain achievement to be linked to the 'Exploring' profile characteristic is not reflected in the low ability group. The definition of the 'Exploring' characteristic may of course be too crude to encompass the possibility that the low ability children were 'Exploring' within interactions in a single phase of the Ecolab.

The manner in which each variation of the system collaborates with the child is a design feature of that variation and as such a big influence upon the resultant user Collaboration Profile. It was no surprise, therefore, that there was a significant association between system variation and collaborative support profile membership. However, it is possible, in principle, for a user of any of the variations to interact in line with any of the Collaboration Profiles described. In reality Collaboration Profile 'Lots and Deep' was exclusive to VIS and WIS users, whereas Collaboration Profiles 'Lots and Shallow' and 'Little and Deep' were exclusive to WIS and NIS users. The only system which allocated both help and differentiation to users was VIS, so the fact that VIS users all used a high quantity and quality of help is unsurprising. WIS users often used a high level of assistance too, but in smaller quantities, they all belong to profiles where the support used was of a high level. In contrast, all NIS users are in profile groups in which the level of support is low. The choice of help available to NIS users was admittedly more limited being of only two levels, however none of the users ever chose to use the higher level of help offered.

The absence of some forms of assistance from the interaction summaries of the less successful users offers support for the suggestion that it is the combination of being challenged, or extended, plus the provision of ample quantities and qualities of support which is important for learning. The lower ability children present a somewhat different picture as there is no apparent consistency between the use of collaborative support and learning gain. The only tentative conclusions are that this group responded to interactions in which the extent of the challenge was limited and that the nature of the assistance the system could offer was not effective for them. Those who were successful took up less different types of assistance and tackled less of the curriculum than their successful more able peers. There is also evidence that these children were not good at managing their own learning. The NIS Interaction and Collaboration profiles in particular would suggest that children who are given control for their own learning experience are not good at setting themselves challenging tasks or indeed seeking collaborative support. Our current work with children is investigating this issue in more depth.

Acknowledgments

This research was sponsored by the Economic and Social Research Council. Thanks are also due to David Wood and Yvonne Rogers for useful discussion and insightful comment upon this work, and to the children and teachers of Blacklands School, Hastings for being enthusiastic participants in the evaluation study.

References

[1] Goodyear, P. Njoo, M., Hijne, H. and van Berkum, J. J. A., Learning processes, learner attributes and simulations , *Education and Computing*, Vol. 6, No (3/4), pp. 263-304, (1991).
[2] Groat, A. &. Musson, T., Learning styles: individualising computer-based learning environments , *Association for Learning Technology Journal*, Vol. 3, No. 2, pp. 53-62, (1995).
[3] Kolb, D. A., *Experiential learning: Experience as the source of learning and development* , Englewood Cliffs, NJ: Prentice-Hall, (1984).
[4] Luckin, R., *Ecolab: Explorations in the Zone of Proximal Development* , (CSRP No. 486). School of Cognitive and Computing Sciences, University of Sussex, (1998).
[5] Luckin, R. & du Boulay, J.B.H., Ecolab: The Development and Evaluation of a Vygotskian Design Framework , *International Journal of Artificial Intelligence and Education*, Vol.10, No. 2, pp. 198-220, (1999).
[6] Pask, G., Styles and strategies of learning , *British Journal of Educational Psychology*, Vol. *46*, pp. 128-148, (1976).
[7] Riding, R. &. Rayner., S., The information superhighway and individualised learning , *Educational Psychology*, Vol. 15, No. 4, pp. 365-378, (1995).
[8] Riding, R. &. Read, G., Cognitive style and pupil learning preferences , *Educational Psychology*, Vol. 16, No. 1, pp. 81-106, (1996).
[9] Valley, K., Learning styles and courseware design , *Association for Learning Technologies Journal,* Vol. 5, No. 2, pp. 42-51, (1997).
[10] Vygotsky, L. S., *Mind in society: the development of higher psychological processes* , (M. Cole, V. John-Steiner, S. Scribner, E. Souberman, Trans.). Cambridge, MA: Harvard University Press, (1978).
[11] Vygotsky, L. S., *Thought and language* , Cambridge, MA:MIT Press, (1986).

Facilitating Examples Understanding through Explicit Questioning

Isaac P.W. Fung and R.H. Kemp
Institute of Information Sciences and Technology
Massey University
Palmerston North, New Zealand
Fax: +64-6-3502259
P.W.Fung@massey.ac.nz; R.Kemp@massey.ac.nz

This paper describes a novel approach for promoting understanding of examples through explicit questioning. Whether being asked by the teachers or self-motivated, studying worked examples is an indispensable step for learners to acquire domain knowledge. The issue is: how could students use examples in the most effective way? Research findings indicate that the utility value of examples among different groups of learners varies dramatically. Effective learners keep self-explaining the solution statements when studying the examples while less effective learners often take each step of the statements for granted. In order to facilitate better understanding of examples, we propose to question the students explicitly on the examples content in order to stimulate their self-explanations. This paper presents the underlying computer model for generating different categories of questions from specific examples. The questions are subsequently used by a case-questioner to test the students on what they have read.

Keywords: **Artificial Intelligence, Conceptual Graphs, Intelligent Tutoring Systems, Case-based Reasoning**

1 Introduction

This paper presents a novel approach to facilitate the understanding of learning materials through explicit questioning. The notion we put forward in the paper forms one distinct feature of our current project: providing problem-solving advice in terms of relevant worked examples. When mapping out the project specification, there is an issue we are particular concerned with: to what extent the students benefit from the examples remains unknown. In her seminal work [2] Chi discovered the phenomenon of self-explanation among effective learners when they are presented with worked examples. Among this group of learners, they have a strong tendency to explain each example statement to themselves before moving on whereas the less effective learners tend to take the example statements for granted. In a follow-up investigation [3] Chi exploited her previous discovery in the context of learning. Not surprising, when students are deliberately prompted for self-explanation, they have shown a dramatic improvement in acquiring the knowledge. We believe the implication of Chi's study is very significant. Not only do the results shed light on understanding different learning behaviours, but the study also challenges instructors that merely informative examples do not guarantee good learning results. How the students use examples is a crucial factor in determining if they are really helping the students understand the subject domain.

As we are concerned with how the students use the examples presented, we decided not to take the present-and-go approach. Once a case (i.e. a relevant worked example) is retrieved for presentation, a case questioner will be automatically invoked to challenge the student's understanding on the knowledge embedded in the case. The questions generated are not explicitly stated in the problem statement. The rationale of this proposal involves encouraging the students to think more deeply while studying the worked examples. If the students have, in fact, understood the examples or related concepts within the domain, they should be able to answer the questions posed by the system. If not, the questions can trigger their attention towards certain aspects of the problem and stimulate their knowledge acquisition process.

2 Promoting Comprehension through Questioning

When studying worked examples, it is quite common for the students to take many solution statements for granted without trying to dig out the embedded tacit knowledge. Even if the students have the intention, they may lack the knowledge structure to find out the tacit knowledge. To put it simply, the student may know that it is helpful to self-explain the statements, but the problem is explaining what? There is research (e.g. [1], [4] and [7]) which indicates that questioning plays a significant role in understanding narrative text and therefore we argue that the same principle should also be applied in comprehending example solutions. If this argument is valid, one potentially pedagogically fruitful approach to tutoring in terms of providing examples is to question the learners on the content of the examples in a systematic way. Once the example is presented, the students will be asked questions driven by physical principles in order to detect what they know about the example and to help them discover meaningful relationships. To illustrate the argument, we consider the mechanics example shown in Figure 1.

Two blocks A & B are resting on a frictionless horizontal plane as shown. If an external force of 10N is acting on A, what is the acceleration of the blocks and the force of contact between them? (The masses of A and B are 3kg and 7kg respectively).

Solution:

$\text{Net Force}_{A\&B} = \text{Mass}_{A\&B} \times \text{Acceleration}_{A\&B}$ *(Applying Newton's 2nd Law on A&B)*

$\text{External Force}_{A\&B} = \text{Mass}_{A\&B} \times \text{Acceleration}_{A\&B}$

$10 = (3 + 7)\ \text{Acceleration}_{A\&B}$

$\text{Acceleration}_{A\&B} = 1\ m/s^2$

$\text{Net Force}_{A} = \text{Mass}_{A} \times \text{Acceleration}_{A}$ *(Applying Newton's 2nd Law on A)*

$\text{External Force}_{A} + \text{Contact Force}_{A} = \text{Mass}_{A} \times \text{Acceleration}_{A}$

$10 + \text{Contact Force}_{A} = 3 \times 1$

$\text{Contact Force}_{A} = -7N$

$\text{Net Force}_{B} = \text{Mass}_{B} \times \text{Acceleration}_{B}$ *(Applying Newton's 2nd Law on B)*

$\text{Contact Force}_{B} = \text{Mass}_{B} \times \text{Acceleration}_{B}$

$\text{Contact Force}_{B} = 7 \times 1$

$\text{Contact Force}_{B} = 7\ N$

Figure 1: A typical Newtonian mechanics example and its solution

When presenting this example, the author must have already made many assumptions regarding the knowledge state of the reader. For instance, it will be assumed the reader knows that the weights of blocks are being cancelled by the reactions from the ground and thus the weights are not included in the calculation; the reader is also assumed to know that the acceleration of the whole system is the same as the acceleration of individual components; and that the external action on A is the same as the external action on the system as a whole in this case. However, these points may not have been mastered by some students. From the perspective of problem-solving, the solution presented is not the only way of tackling the problem. For instance, the contact force on B can be evaluated immediately by relating it to the contact force on A with which is formed an action-reaction pair. Alternatively, the problem can be tackled by solving three simultaneous linear equations with variables a, f_A and f_B which stand for the unknown physical quantities which are sought. This knowledge is not explicitly shown in the solution statements and the students whose self-explanation is less active may miss these knowledge units. Therefore, a fruitful tutorial dialogue can be created by conducting a series of question-answering episodes on the example presented.

3 A Taxonomy for Different Types of Questions

Before asking a question, the questioner must perform two steps: the first is to decide the *content of the enquiry*; and the second is to compose the *style of the queries*. To pose appropriate questions to the comprehender, the question designer must have a semantic category of questions. We have adapted the taxonomy for questions in narrative understanding originally developed in [8] into the context of physics problem-solving, and this is summarized below in Table 1. Note that except for question No.4, all the questions are relevant to the example shown in Figure 1.

CATEGORY	SPECIFIC EXAMPLES IN THE DOMAIN OF PHYSICS
1. Verification	*Is the system in equilibrium?*
2. Disjunctive	*Is force a vector or a scalar?*
3. Concept Completion	*What is FORCE?*
4. Feature Specification	*What does a convex lens look like?*
5. Quantification	*How many external forces are acting on block A?*
6. Causal Antecedent	*What caused the blocks to accelerate?*
7. Causal Consequence	*What are the consequences of the external force acting on the blocks?*
8. Goal Orientation	*In the 4th line of the solution, why are the masses of A and B summed?*
9. Enablement	*The blocks have weights; what is needed to prevent them from moving downward?*
10. Instrumental/ Procedural	*How was the acceleration of the blocks evaluated?*
11. Expectational	*What will be the magnitude of the contact force acting on A, if the mass of B is increased but the external action remains unchanged?*
12. Judgmental	*Do you think the solution presented is the only possible method?*

Table 1: Twelve Semantic Categories in Question Taxonomy (Adapted from [8])

4 Questions Generation

4.1 Based on the Definition of Concept Types

The questions in the categories 1, 2 and 3 are related to the definition of some domain-specific terminology and hence are grouped together. These categories of questions require the comprehender to grasp the definition of the focal content of the questions. For the question "Is the system in equilibrium?", the focus is on testing the readers on the precondition of a system being described as "in equilibrium". The question "Is force a vector or a scalar?" assesses the student's knowledge of the difference between vector and scalar quantities. There are two ways of generating these categories of questions: by *traversing the type hierarchy* and by *projecting* the definitional graph of the focus type into the conceptual graph [9] representing the example [5]. Based on these methods, the following scenarios can be developed. Question: "Why is the system not in equilibrium?" If the student successfully answers the net force acting on the system is not zero, another question can be generated such as "Then how can it be put into equilibrium again?"

4.2 Based on the Chaining of the Graph Nodes

In Newtonian mechanics, there are causes that are well-defined, such as the cause of acceleration being a non-zero net force; the cause of a change in velocity being non-zero acceleration; the cause of a change in position being a non-zero velocity, etc. The whole process of deriving values for unknown variables from available data can be modelled as a node chaining process, a kind of causal chaining. Figure 2 shows two subgraphs that represent the corresponding example statements:

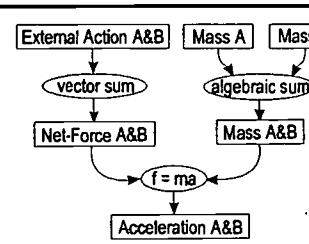
Solution Steps	Corresponding Conceptual Graphs
$\text{Net Force}_{A\&B} = \text{Mass}_{A\&B} \times \text{Acceleration}_{A\&B}$ $\text{External Action}_{A\&B} = \text{Mass}_{A\&B} \times \text{Acceleration}_{A\&B}$ $10 = (3 + 7) \times \text{Acceleration}_{A\&B}$ $\text{Acceleration}_{A\&B} = 1\ m/s^2$	

Figure 2: Part of the solution steps and its corresponding conceptual graphs

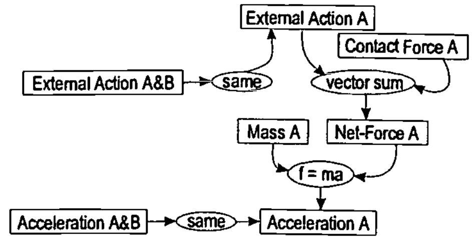
Solution Steps	Corresponding Conceptual Graphs
$\text{Net Force}_A = \text{Mass}_A \times \text{Acceleration}_A$ $\text{External Action}_A + \text{Contact Force}_A = \text{Mass}_A \times \text{Acceleration}_A$ $10 + \text{Contact Force}_A = 3 \times 1$ $\text{Contact Force}_A = -7\text{N}$	

Figure 2 (cont'd): Part of the solution steps and its corresponding conceptual graphs

The graphs shown on the right hand side of Figure 2 provide ample material to generate questions to test students' understanding of the solution steps such as "How was the acceleration of the system evaluated?"; "How many external forces act on the block A?"; "What is the relation between the acceleration of A and the acceleration of the whole system?"; "How was the contact force on B evaluated?", etc.

4.3 Based on Propagating Qualitative Values across the Graph

Regarding the expectational question depicted in the 11th category, one should see that it belongs more to the area of qualitative reasoning (QR) [11] and this kind of question is very common in testing the knowledge of students. A QR technique had been developed in [6] and the following type of questions are successfully generated. "If the external action decreases, what would be the contact force?" "If the bottom of block A is made rough to create friction between A and the ground, what would be the acceleration of the system and the contact forces?"

5 Conclusions

This paper proposes a questioning approach to handling examples, which is intended to stimulate the student's cognitive process of self-explanation. Representing worked examples by CG allows the system to generate different categories of questions during the questioning process. We have shown that definitional, procedural and qualitative questions can all be posed to students for tutorial purposes. Due to space limitation, we have not covered all categories of questions; for instance, feature specification and enablement. At the moment, this part of the work derives only from a computational perspective and lacks empirical support. The next phase of our project is to test posing the questions to students to see if this approach would stimulate self-explanations and subsequently enable them to acquire a better understanding of the subject domain.

References

[1] Anderson, R.C. & Biddle, W.B., "On asking people questions about what they are reading." In G. Bower (Ed.) The Psychology of Learning and Motivation (Vol. 9), NY: Academic Press, (1975).

[2] Chi, M.T.H. et al., "Self-Explanation: How students study and use examples in learning to solve problems, Cognitive Science, Vol.13, pp. 145-82, (1989).

[3] Chi, M.T. H. et al., "Eliciting self-explanation improves understanding" Cognitive Science, Vol. 18, pp.145-82, (1994).

[4] Dillon, J.T., "The multidisciplinary study of questioning" Journal of Educational Psychology, Vol. 74, pp. 147-65, (1982).

[5] Fung, P.W. "Designing an case-based intelligent learning environment in physics with conceptual graphs" Ph.D. Thesis, Dept. of Computation, UMIST, England, (1996).

[6] Fung, P.W. "Generating qualitative predictive problems in a case-based physics tutor" In Proceedings of AI-ED97, World conference on artificial intelligence in education, Kobe, Japan, (1997).

[7] Graesser, A.C. & Black, J.B., "The psychology of questions" NJ: Lawrence Erlbaum Associates, (1985).

[8] Graesser, A.C. et al. "A taxonomy for question generation" Questioning Exchange, Vol. 2, pp. 3-15, (1988).

[9] Sowa, J. "Conceptual structures: Information processing in mind and machine" Reading: MA: Addison-Wesley, (1984).
[10] Trabasso, T., et al. "A model for generating questions that assess and promote comprehension" Questioning Exchange, Vol. 2, pp.25-38, (1988).
[11] Weld, D.S. & deKleer, J. "Readings in qualitative reasoning about physical systems" CA: Morgan Kaufmann Publishers, (1990).

IT in Instrumental Music Teaching and Learning: Some Practical Ideas

Barry Kwok-yeung Lee
Department of Information & Applied Technology,
The Hong Kong Institute of Education,
10 Lo Ping Road, Taipo, N.T., Hong Kong.
Phone: +852 2948 7724; Fax: +852 2948 7726
E-mail: blee@ied.edu.hk

This paper describes the potential use of information technology (IT) in practical music teaching and learning. The incorporation of IT into instrumental music curriculum can open up an entire music context for both teachers and students. IT integration in the instrumental music curriculum offers the potential to provide students with unique musical experience that was not possible in the last decade. IT can broaden the spectrum of instrumental instruction, providing more information, more resources, and a better understanding of the subject area. There have been substantial reports of success about the enhancement of traditional music teaching with IT. Based upon these experiences, current orchestral instrumental teaching practice has been examined to explore opportunities for technology integration. Areas appropriate for integration were identified with specific reference to current practice in instrumental instruction. Examples of technology-based instrumental music instruction were discussed and analyzed, providing reference for further investigation.

Keywords: **IT Integration, Music Technology, Instrumental Teaching**

1 Introduction

Throughout the world, IT is changing the way music is taught in the school music curriculum. Many music teachers have already incorporated IT in general group music teaching in the classroom. It is obvious that IT has the potential to radically change the fundamental processes involved in the teaching and learning of orchestral instrument that is more adhered to small group or individualized teaching.

A review of literature about music education oriented IT application indicated that IT has been used in a variety of classroom activities such as composition, group keyboard lessons, music theory, rhythm training, aural training, music reading, harmony, music appreciation and music accompaniment etc (see [1], [4], [5] & [12] for more details). Based upon successful instances of classroom applications in IT cited in the literature, consideration is being made to incorporate IT in instrumental music teaching and learning.

2 IT opportunities in Orchestral Instrument Instruction

Rudolf [12] noted that "the best way to select the ideal use for technology is to first focus on the desired goals and educational outcomes and then select the materials or devices best suited to accomplish the stated goals" (p. 76). In fact, as pointed out by Willman [13], "some portions of the curriculum may be enhanced greatly through the use of technology; others may be taught best using more traditional techniques" (p. 33). In this regard, the practical aspects of instrument instruction should be taken into account when considering the integration of IT in instrumental teaching. Instrumental teachers must choose IT that can match their instructional goals. IT applications should therefore be determined by the desired instructional activities that can be best supported through IT strategies.

In general, a typical instrumental lesson can be divided into four sections, namely the (a) technical studies, (b) pieces, (c) scales and arpeggios, and (d) sight-reading and aural. A review of the contents of syllabuses of major international practical music examination revealed that technical works - scales and arpeggios, studies, repertoire pieces, aural training, sight-reading, and general knowledge of individual instrument are key learning areas. As a considerable number of music software are now available, capable of catering for a wide variety aspects of music education; coupled with the software's versatility and flexibility, information technology can be applicable to the instruction of most these areas.

With the substantial reduction of the cost of multimedia notebook computers, instrumental teachers can carry not only his/her musical instrument, but also a computer that can be put inside his/her briefcase. For instrumental teachers, software such as sequencing, ear training, and multimedia CD-ROM are specially useful. In particular, sequencing software, like Cakewalk for example can serve a number of purposes in instrumental teaching.

Firstly, sequencing software can be used as an interactive staff board, teachers can write notes, chords, melodies or rhythmic patterns freely on the staff. With the simultaneous tone reproduction function, pressing either the "Scrub" or "Play" button will output the sound of individual notes, chords, melodies or rhythmic patterns. As a comprehensive list of western musical instruments is available for output selection, this function can virtually support the teaching of almost all instruments. The teaching of tuning, rhythm, ornaments, scales and arpeggios can also be supported. In teaching tuning, computers can provide a secondary sound source of, or other than, students' instrument to develop their ability to identify unmatched sound so that their competence in playing in tune can be attained. For the teaching of rhythm, ornaments, scale and arpeggios, teachers can create the required note patterns prior to the lesson. With the assistance of computers to illustrate these note patterns during the lesson, a more precise illustration can be provided. Coupled with the close to real play back function at the desire speed, students can have a much clearer view and a better grasp of the idea of these fundamentals. Although teachers can provide the demonstration that can never be replace, with the assistance of computers, teachers can be more attentive to students' performance; while instant interaction, feedback and instruction can be given.

Secondly, sequencing software can provide accompaniment, either orchestral or piano, to the music pieces to be performed. In general, pieces are usually performed with accompaniment. Teachers can prepare the respective piano or orchestral accompaniment in the form of MIDI for play back during lesson through the multimedia audio device of the computer. With the introduction of computer accompaniment, the time, cost and effort to organize a piano accompanist can greatly be reduced as the physical piano accompanist is only required for the last few rehearsals. Of course, instrumental teachers can also act as piano accompanists to a certain extend. However, in most cases, instrumental teachers may not be good pianists or the accompaniment part is just beyond the ability of the instrumental teachers. In addition, the piano may not readily be available in the room where the instrumental lesson is conducted. Moreover, if the pieces are to be accompanied by an orchestral group, computer-generated accompaniment can provide a more realistic simulated circumstances for students' practice, which is particular difficult to organize in real life, it will be very costly to organize an orchestral accompaniment group. In teaching the repertoire pieces with computer mediated accompaniment, teachers are able to watch the performance of the students at all times and evaluate students' performance. The presence of computer-mediated accompaniment enables instrumental teachers to focus more on students' performance in terms of expression, dynamics, tempo and interaction with the accompaniment part. Also, if students have their own computer, students can be given the floppy disk containing the orchestral or piano accompaniment file so that more accompanied individualized students' practice is possible. Undoubtedly, computer-mediated accompaniment provides students at all levels with a complete musical context for solo practice.

One of the important aspects of instrumental teaching is demonstration. Teachers' demonstration provides students with a model for imitation. Demonstrations provided students with an over picture about the pieces to be learned including style, speed, touch and rhythm. In addition to teachers' live performance demonstration that can provide a more detailed interpretation of music and pieces to be learned can be played back with the multimedia digital audio and video facilities of the computer. Compact Disc (CD) and Video Compact Disc (VCD) recordings of music performed by maestro can be played back and will be helpful in assisting students to appreciate and analysis the pieces, and produce direct interaction and influence.

For aural training, there is a wide variety of software available that provides computer-aided drill-and-practice instruction for ear training. Teachers can conduct drills such as interval dictation, rhythmic dictation, melody recognition etc. during instrumental lessons. As ear-training software are becoming popular and relatively inexpensive, some can even be downloaded for free or only at a minimal cost from certain web sites in the Internet. Students can practice on their own outside the normal lesson hours. As most of the aural tests are conducted with the sound of piano, if teachers are not comfortable with the pre-determined contents of these software, teachers can use sequencing software to tailor make some aural training materials that adhere more to the level and needs of individual students.

For the teaching of general knowledge, there is a large and ever increasing number of multimedia resources in the form CD-ROM available that could be an ideal media to support instructional delivery. Multimedia CD-ROMs provide teachers with a context that is rich in digitized audio-visual resources including sound, text, graphics and video. Teachers can make use of these CD-ROM to illustrate information about a musical instrument such as physical structure, method of tone generation, members of same family, and the development and evolution of a particular instrument. By playing back musical extracts, tone colors of instruments constructed in different periods can be heard and compared. To introduce a piece of music composed in a particular period, information about the composer such as biographical details can easily be displayed. By playing back music of the same period composed by same composer or other contemporary composers, musical styles of a particular period or particular composer can better be illustrated and analyzed. This is particular useful for students who need to perform a piece of music that was composed in earlier musical periods, with students able to have a better ideal of the musical styles of that particular period. These CD-ROM titles not only provide students with the musical styles that can be heard or visualize from audio or video CD, but also a concrete historical, cultural and social background of music from different periods.

3 Conclusion

With the sophisticated software and hardware that are now accessible at affordable prices to both teachers and students, information technology has a great potential for supporting instrumental music teaching. IT applications in instrumental lessons provide a computer-mediated environment which can stretch out the limit of traditional delivery system. Limitations encountered under traditional delivery systems due to unfavorable mode of information retrievals and dissemination could be reduced or even eliminated, so that the teaching of key areas in instrumental instruction can be much enhanced. Coupled with instrumental teachers' professional knowledge, a much favorable learning environment can be created, enabling the music experience provided to students be further heightened. More importantly, with the support of IT, students' learning can occur in a real musical context that is full of musical facts, knowledge and a virtual space in which musicianship can be developed that adheres more to a professional performer.

Reference

[1] Altiere, L., "Teaching Idea" in Stinson, C. (Ed.), Technology-rich teaching. Teaching Music, vol. 4, no. 2, pp. 30-32 (1997).
[2] Booty, C. Ed., "TIPS: Technology for Music Educators", Music Educators National Conference (1990).
[3] Bray, D., "CD ROM in music education", British Journal of Music Education, vol. 14, no. 2, pp. 137-142 (1997).
[4] Carpenter, R., "Technology in the Music Classroom", Alfred (1991).
[5] Dunnigan, P., "The Computer in Instrumental Music", Music Educators Journal, vol. 80, no. 1, pp. 32-37, 61 (1993).
[6] Klinger, M., "The One-Computer Music Classroom", Teaching Music, vol. 3, no. 3, pp. 34-35 (1995).
[7] Lee, B.K.Y., "Technology Based Music Instruction: Multimedia Applications in Music Teaching" in Volk, K.S. (Ed.), Science & Technology Education Conference '98 Proceedings, pp. 244-252, Hong Kong Institute of Education. (1998).
[8] Lee, B.K.Y., "IT Opportunities in Primary Music Curriculum in Hong Kong: Potentials and Obstacles". In Cumming, G; Okamoto, T & Gomez, L eds, Advanced Research in Computers and Communications in Education (Amsterdam: IOS Press), pp 86-89 (1999).
[9] Muro, D., "Technology: A tool for music education", Teaching Music, vol. 4, no. 5, pp. 28-30 (1997).
[10] Murray, A., "The Music IT Pack", National Council for Educational Technology, UK (1997).
[11] National Council for Educational Technology, UK, "Primary Music: a Pupil's Entitlement to IT", Author (1996).

[12] Rudolph, T.E., "Teaching music with technology", Chicago, Ill.: GIA (1996).
[13] Willman, F., "New Solutions to Curricular Problems", Music Educators Journal, vol. 79, no. 3, pp. 33-35,68 (1992).

Learning from the Learning of other Students

Stuart Garner
Edith Cowan University
Pearson St., Churchlands, 6018, Western Australia
email: s.garner@ecu.edu.au

This paper concerns the use of dialogues in student learning and how such dialogues can be captured for subsequent use by other learners. The process of learning by observing another person' s learning is known as vicarious learning. The paper begins by discussing the movement towards more flexible types of learning and the belief by many that traditional dialogue has been omitted from a lot of today' s courseware. Dialogue can be considered as one of the stages in the learning cycle and to support it there is a need to create tertiary courseware, this being the third stage in the cycle. Some of the research that has taken place into vicarious learning is described and this has shown that it has some benefit to learning and also produces positive feelings in students of being part of a learning community. Finally the vicarious learning resources that have been produced within a software development course at Edith Cowan university using a dynamic screen capturing tool are discussed together with a possible dissemination system.

Keywords: **Distance Education, Flexible learning, Vicarious Learning, Programming**

1 Introduction

Universities and colleges today have record numbers of students and yet the cost being spent per student is steadily decreasing as budgets are cut and universities become ever more competitive. One of the consequences of this is that many managers are turning to the Internet as a means for delivering courseware to students in a supposedly cost-effective manner. Students are also demanding more flexible learning with learners being able to learn when they want (frequency, timing, duration), how they want (modes of learning), and what they want (that is learners can define what constitutes learning to them) [14].

The situation has therefore arisen that students spend more time away from a traditional campus and technology is being used to provide the necessary flexibility with computer networking empowering connectivity and communication, allowing synchronous and asynchronous one-to-one and one-to-many communication [13]. However, such technology does not necessarily support some of the learning situations that are necessary in higher education. Laurillard [6] points out that learning in many educational contexts, particularly in higher education, requires learning about descriptions of the world, knowledge derived from someone else's experience, and from understanding someone else's arguments. She states that:

> *We cannot claim to have sorted out once and for all what students need to be told if they are to make sense of topic X. No matter how much detailed research is done on the way the topic is conceptualised, the solution will not be found in new ways of putting it across. The new way of telling may sort out one difficulty, but it may well create others. All we can definitely claim is that there are different ways of conceptualising the topics we want to teach. So all we can definitely conclude is that teachers and students need to be aware of those differences and must have the means to resolve them.*

The main way this has been done in the past has been by students participating in dialogue with fellow students and their tutors. We do have email and synchronous "chat" available to support dialogue to some extent but it may well be argued that this is insufficient to support the above.

2 The Learning Cycle

Dialogue can be considered as a crucial part of the learning cycle [9]. The cycle is shown in figure 1.

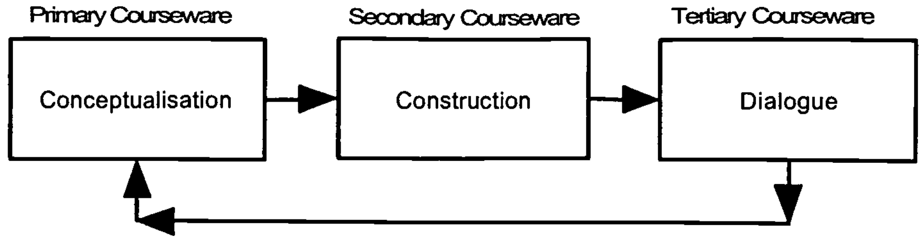


Figure 1: The learning Cycle

It can be considered to comprise:

- conceptualisation which comes from interacting with the primary content and relates to a learner's current state of understanding.
- construction and the use of knowledge occurs with the use of secondary courseware tools such as concept mappers. It involves picking out particularly relevant material, putting the information together in ways which have meaning for the learner, and relating old and new material into a coherent whole.
- dialogue which involves the testing of understanding and can possibly be facilitated with tertiary courseware.

Mayes et al [9] suggest that the third section of the learning cycle, dialogue, can itself be broken up into three stages, these being discussion, reflection and reification. Mayes et al agree with Laurillard that discussion is fundamental to effective education and that a deep understanding is promoted far more effectively and efficiently during discussions. Reflection has always been thought to be an important aspect of learning and can be considered as the testing of new knowledge against the schemata that hold our existing knowledge. And finally reification is a term put forward by Mayes et al and concerns the structuring of newly acquired knowledge into a new object of thought integrated with other knowledge.

The question then arises as to what sort of tertiary courseware can be produced and utilised to support the dialogue aspect of the learning cycle bearing in mind that the material will have to be used in flexible learning environments. One particularly interesting line of research has been into recording of discussions and making them available to other students in a flexible mode. This concept is known as vicarious learning where this is defined as [2]:

> *The potential benefit to learners of being able to observe or 'listen in' on experts or their peers as they discuss a new topic.*

The following can be considered to be vicarious resources:

- Frequently asked questions (FAQs). Here students can learn from the answers to typical questions posed by other students.
- Listservers. These promote vicarious learning as students receive the text dialogues that take place between various subscribers. The term "lurker" is often used for the person who does not participate in dialogues but prefers to simply observe.
- Bulletin boards. These provide the means for asynchronous dialogues and again can be used by "lurkers".
- Chat rooms. These provide the means for synchronous dialogues.

3 Research into Vicarious Learning

Research initiatives are in two main areas, the first attempting to determine if vicarious learning is of benefit to students and the second looking at how such dialogues might be made available as tertiary courseware for re-use by other students.

There are several interesting questions that might be worthy of investigation in the first area. Cox et al [2] suggest that we need to determine who are useful models for the vicarious learner, experts or novices. It might be better to observe experts as skilled behaviour would hopefully be modelled in a clear way, although this is not of course always true as many experts find it difficult to make their knowledge explicit. It could be argued that student – student dialogues would be better to observe as the observing student would be better able to identify with other students. Also the students participating in the dialogue might use more appropriate language and also ask questions of each other that they may not have wished to ask their tutor. Cox et al also point out that observing unskilled behaviour may also prove to be of benefit as the observing student would determine from the dialogue what sort of errors to avoid without having to make those errors themselves. Also of course, the dialogue type to observe may depend on the type of student who is the observer. It might be more appropriate for a strong student to observe experts and for a weak student to observe novices.

In one particular piece of research on vicarious learning [7] benefits were found that were both cognitive, with an increase in knowledge and understanding in the particular curriculum area, and social with exposure to peer discussion creating positive feelings of being part of a learning community.

Lee et al [7] carried out research within an on-line Masters level course in Computers in Teaching and Learning. They created task-directed discussions (TDDs) in order to capture good learning dialogues amongst students and to overcome the "barriers of silence" that might otherwise occur. Over 30 hours of discussions among students, and between students and a tutor (the expert), using the TDDs were videoed.

An architecture called the Dissemination System (DS) was created from primary instructional materials and integrated clips taken from the videos. The DS allows a multimedia database of video and audio clips, text transcriptions, and annotated graphics to be integrated with primary expository teaching material and delivered via the Web. The system was then used in an experiment to investigate the vicarious resources in a controlled laboratory setting.

The experiment used a section of the course on Models of Learning with Technology. Two sets of learning materials were created, the first comprising primary learning materials (approximately 45 web pages) and the second comprising both primary learning materials and an integrated set of vicarious learning resources. The vicarious resources had been obtained from the videoed dialogues and comprised 108 video clips, 13 audio clips, 43 text transcriptions, and 27 audio annotated graphics. The resources were accessible by either clicking on highlighted keywords or by a search mechanism.

Two groups of students took part in the experiment, one using only the first set of learning materials whilst the other used the second set of learning materials which included the vicarious resources. The conclusions that Lee et al drew from the experiment were that there were some benefits in learning and substantial positive changes in attitudes and discussion behaviour for the students who used the vicarious learning resources. The researchers also make the point that although some people claim that learning can only take place when students are personally engaged in discussion, the evidence suggests that observing peer dialogues can, on the contrary, provide a useful source for learning, both cognitively and socially. The researchers have in fact suggested that such vicarious learning may sometimes be more beneficial than being a participant, depending on the state of the learner [11].

The web based materials used in the experiment are available at http://www.hcrc.ed.ac.uk/Vicar/TT/. They are fairly slow to download from the Web but realistically they could be put onto a CD ROM for use with distance learners. The audio dialogues that are available are played whilst a static graphical image is displayed to the learner. Such a dialogue concerns the graphic being displayed and I felt that something was lost in this type of dialogue and that it would have proved to be more useful and meaningful if objects on the graphic could have been "pointed to" in order to draw the observer's attention to the important aspects of the graphic.

4 Creation of Vicarious learning Resources with Dynamic Screen Capturing Tools

During the summer school of 1998 at Edith Cowan University, I made use of Lotus ScreenCam for student-tutor dialogues within a Software Development unit. Between lectures and laboratory sessions, students had no contact with me as I was off campus, however I did have access to email at home enabling students to send me ScreenCam movies of any programming problems that they were having. In addition to movies, students would also send the programming code enabling me to use this when making a "reply" movie. An example of a screenshot taken from a movie, which was sent to me by a student, is shown in figure 2.

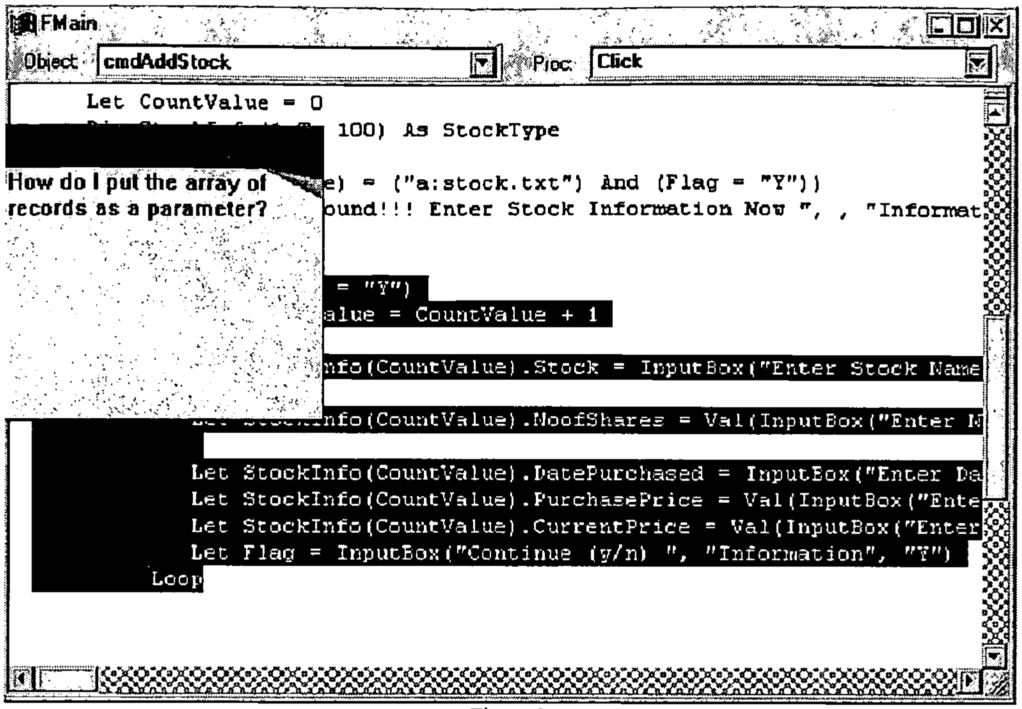


Figure 2

The movie had several text captions and concerned a problem that this student was having with passing arrays to subprograms in Visual BASIC. A screenshot taken from the movie, which I made and subsequently sent back to the student, is shown in figure 3.

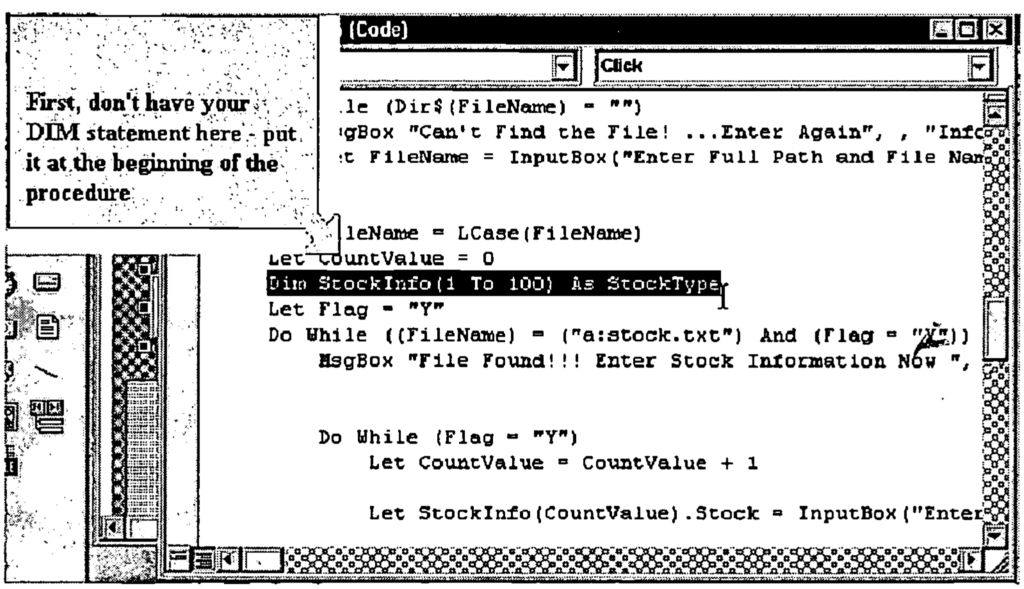


Figure 3

The screenshot in figure 3 includes a text caption that has nothing to do with the original student problem. It is the sort of comment that I would make if I were looking at the code that a student had produced in a laboratory session. In the rest of the movie, I was able to make suggestions on how to overcome the original problem and I also included a captioned comment about the lack of comments within the student's programming code. By using ScreenCam, I had been able to engage in a richer asynchronous dialogue with the student than I would otherwise have done by conventional means. In addition, as a side effect, I was building up vicarious learning resources for use in future semesters.

In addition to capturing asynchronous dialogues as described above, Lotus ScreenCam can be used to provide rich feedback to students on their assignment work. Simple "low-tech" audio tapes have been used in student feedback [1] and it is suggested that such feedback adds a social dimension to the commentaries with the tutor being able to talk personally to each student, whereas written comments lacked context and sounded impersonal.

I produced a set of such movies for the small group of campus-based students that were involved in the 1998 summer school session mentioned earlier. Each week the students attempted a small programming problem and handed in the relevant programming code together with a small text-captioned movie explaining their program. I then made a feedback movie for each student. Each feedback movie had audio commentaries to keep the production time to a minimum and the movies were placed onto ZIP disks that had been provided by the students. I was able to go through the programming code on the screen, highlighting areas of interest with the cursor whilst making comments and in addition run the student programs with a variety of data whilst passing comments about both the good and the bad points of the programs.

The sets of movies that the students handed in and that I produced have now become another vicarious learning resource for use by students in subsequent semesters. Each week, students are given a small programming problem to attempt and they can then use the movies to view the student – tutor interactions for a similar programming problem. In practice, students have commented on how useful they have found these resources. Feedback was elicited on-line and some of the comments follow:

- I found it helpful and interesting in giving clear visual instructions or explanations.
- All the other students solutions were very helpful. And they were informative.
- Only used the movies once, but they do provide a good resource for students experiencing difficulty.
- Pick up other students mistakes.
- Always forgot how to get to them
- Probably slack, but using the sound was too much hassle.

5 Delivery Mechanisms for Vicarious Resources

The last two student comments above indicate that there is a need for some form of technological delivery mechanism for the vicarious resources that have been produced that is simple and easy to use. Students need to be able to quickly find movies that are appropriate for the programming problem that they are attempting and then view the movie. We have experimented using the Web to deliver the movies however this has been a problem as movies with audio are of the order of 1MB in length per minute and take too long to download. Realistically it is necessary to make the movies available on CD ROM and we will be using a Windows Help file as a way of delivering the movies. There are several Help file authoring tool available and one that I have used extensively is ForeHelp [4]. A Help file can be produced with the usual contents and index pages with little effort and programs can be launched seamlessley thereby permitting the running of ScreenCam movies.

6 Discussion

It would appear that the use of vicarious learning resources by students can benefit learning and also provide positive feelings of being part of a learning community. However the creation of such resources needs to be done very carefully so that they are relevant and of interest to learners. If a synchronous dialogue is to be recorded by the use of video or audio then it is important to use task directed discussions [7] to ensure that a relevant dialogue ensues. Asynchronous dialogues usually take place by email or bulletin boards, however they can be made richer if a dynamic screen capturing tool is used. Finally the vicarious learning resources that have been collected need to be made available to other learners and to this end Lee et al created a web based dissemination system. Another approach is to use a Windows Help file for disseminating such resources assuming that delivery is to be by Wintel hardware only.

In the future I intend to look at capturing synchronous dialogues using a dynamic screen capturing tool. These would be both student – student and student – tutor where the two participants sit in front of a PC whilst having a dialogue concerning a program that is being displayed.

References

[1] Anson, C. M. (1997). In Our Own Voices: Using Recorded Commentary to Respond to Writing. New Directions for Teaching and Learning, Spring 1997(69), 105-113.

[2] Cox, R., J. McKendree, et al. (1998). Learning vicariously from educational dialogue and discourse. 20th Annual Conference of the (US) Cognitive Science Society, Madison, Wisconsin.

[3] Domingue, J., & Mulholland, P. (1997). Teaching Programming at a Distance: The Internet Software Visualization Laboratory. Journal of Interactive Media in Education (http://www-jime.open.ac.uk), 1, 1-28.

[4] ForeHelp User' s Guide (1995). ForeFront Incorporated

[5] Garner, S. (1997). Cost Effective Multimedia Production for Frequently Updated Courseware. Paper presented at ASCILITE 97, Curtin University, Perth.

[6] Laurillard, D. (1993). Rethinking University Teaching: A Framework for the Effective use of Educational Technology, London Routledge.

[7] Lee, J., F. Dineen, et al. (1999). Vicarious Learning: cognitive and linguistic effects of observing peer dialogues. American Educational Research Association (AERA '99), Montreal, Quebec.

[8] Lotus Corporation. (1997). White Paper (Technical) http://www.lotus.com/home.nsf/welcome/screencam, (accessed on June 23, 1999)

[9] Mayes, J., J. McKendree, et al. (1996). The Vicarious Learner: Rethinking the use of dialogue in teaching and learning, http://www.hcrc.ed.ac.uk/gal/vicar/VicarPapers/vicar.html (accessed on Aug 4, 2000).

[10] Mayes, J. T., & Neilson, I. (1996). Learning from other People's Dialogues: Questions about computer-based answers. In B. Collis & G. Davies (Eds.), Innovating Learning with Innovative Technology. Amsterdam: North-Holland.

[11] McKendree, J., K. Stenning, et al. (1998). "Why observing a dialogue may benefit learning." Journal of Computer Assisted Learning **14**: 110-119.

[12] Neville, L. (1995). Sense-making and Sensitivities: New Pedagogies? New Practices? New Acceptance of Old Ways of Learning? Australian Educational Computing (May 1995), 15-19.

[13] Nikolova, I. and B. Collis (1998). "Flexible learning and design of instruction." British Journal of Educational Technology **29**(Jan. '98): 59-72.

[14] Van den Brande L (1993). Flexible and distance learning John Wiley, Chichester, UK

Making the Most of the Internet for Potential for Education

John Wang* and Dilek Sanver**
**RS Information Systems, Inc./university of California, Berkeley*
3402 Sepulveda Blvd, #421, Los Angeles, CA 90034, USA
Telephone: (805) 982-3312
Fax: (805) 982-2659
Email: jgwang@csua-berkeley.edu
***University of California, Irvine*
Irvine, CA 92697, USA
Telephone: (310)390-7429
Email: dsanver@uci.edu

Who is building Web sites today? Entrepreneurs, writers, hobbyists, educators and students from the elementary grades and up are building them, not Java programmers, In fact, very few Web sites are actually built by professional programmers That is why strategies for making the most of Internet' s potential for education is important: It brings the power of Internet to non-programming Web-builders like teachers and their students. Internet is an exciting, dynamic technology that is challenging for education. With new specifications, new classes, and general updates, one must accept the fact, when integrating Internet Technology into instruction, that the course will never be the same because the subject matter is in a never-ending state of change. In today' s technological environment, curriculum development must be iterative; in other words, it is an ongoing repetitive process that is required due to the constant change of the subject matter and the technology. In order to be making the most of Internet's potential for education, we proposed these six basic phases--- understanding, planning, research, development, refinement and implementation. This article describes how to effectively use this six-phased approach Follow these phases, the educators and learners can collaborate to enhance existing material and produce new innovations for education.

*The paper was not available by the date of printing.

Networked Constructive CAI System Putting Emphasis on Communication and Discussion—An Example of Proportion-concept in Mathematics of Elementary School

Pou-Yah Wu*, Yi-Ling Lu, Ruey-Chuan Wu, Hsiao-Yun Wu and Shin-Pey Chen**
Department of Mathematics Education, National Tainan Teachers' College, Taiwan
E-mail• *pywu@ipx.ntntc.edu.tw **a8817209@wwes.tnc.edu.tw

New courses in mathematics of elementary school in Taiwan emphasize constructive pedagogy about solving problems, reflection, studying and learning, communication and discussion. The development of computer technology provides the environment of discussion, facilitating the convenience for communication. This study adapts itself to the change of teaching material for new courses, establishing connection by the operation of lineal graph. As far as the system is concerned, via elucidating the process of solving the problems, the system attain the effect of reflection; it establishes the virtual students and room for on-line discussion to achieve the aims of studying and learning, communication and discussion; letting the platform to the students to fulfill the concept of constructive pedagogy. After the future leased network become more popular and the computer interfaces become more humanized, we believe that the effects of communication and discussion will become better. Besides, the norms of discussing the order in this system will leave much to be desired.

Keywords• **CAI, mathematics of elementary school, proportion concept, Web-based learning.**

1 Introduction

New mathematics courses of elementary school in Taiwan adopting constructive pedagogy in 1993, thinking that the learning of mathematics knowledge is cultivated gradually in the processes of solving the problems, reflection, discussion and modification. Mathematics' meaning is formed individually, but the accumulated thoughts of the wholly social mass and cooperation can provide the best learning environment of mathematics. We hope that we can provide the learning environment of mathematics from the accumulated thoughts and cooperation by means of the networked constructive learning environment. The constructive pedagogy of new courses aims at the communication and discussion between the students[1]; however, communication and discussion waste much time. Thus, there is deficiency of time in teaching in the real pedagogy; nevertheless, the discussion of the virtual students and networked on-line learning can well make up the limitation of time and space, owing to the fact that the learning activities can be carried on at any moment and at any place through the network. The need of clarifying the concepts to communicate and discuss between emphasized by new courses can also come true. This study aims to associate the virtual students and networked learning, designing networked constructive learning environment, providing a environment for communication and discussion, helping students construct the concept of proportion, letting the communication can be undertaken immediately between the learners, between the learners and the virtual students, making up a wholly cooperative learning environment, thereby facilitating the students to clarify and to develop mathematics concepts.

2 Principles of System Construction

2.1 Basis of Learning Theory

Constructive pedagogy let the students establish his conceptual structure with new things; the teacher helps the students construct knowledge only. Thus, the teacher plays the role of posing the problems; the real solver of the problems is the student. Basically constructivism stresses the concept of learner-centeredness. With a view to fulfilling the educational ideal of child-centeredness, new courses emphasize the students' natural thought and the individual difference[1]. Why the students' natural thought be stressed? Because the learner has to construct knowledge positively, and he constructs the knowledge on his own natural thought. To adapt the various natural thoughts, in addition to "time difference" of the individual difference in the process of the students' learning, the so-called "route difference" is added [3]. Thus, the learner may adopt different ways of solving problems to form various records. New courses stress the activity of solving problems and reflection to accumulate related experiences of activities to serve as the foundation of upholding mathematics knowledge. Thus, the issued culture within the class in the lower grade courses, then, emphasizing discussed culture in classes of higher grades, partly discussing students via classes, and partly reflecting his own thoughts about solving questions[1].

2.2 Basis of Course Content

Old courses in 1975 emphasize the processes manifested; therefore, what the old courses lay stress on the proportion concepts is the exercise of the abstract meaning on ratio, thus looking upon the definition of "ratio" as the multiplicity relationship between comparative amount and that of standard, and using the viewpoint on "A• B=A ÷ B =A/B" to look at the questions of ratio; while what new courses emphasizes is the process that children construct mathematics concepts, therefore new courses think radio is two amounts A and B, causing the match relationship owing to some reason, calling these number A and B have equal relationship., and using "radio" is "A• B" to record the equal relationship between A and B, considering the question of ratio is based on equal relationship and transfer to another equal relationship of the same value, via the simultaneous repetition and the equal cut activity of the two amount of the equal relationship [2]. The previous activity of ratio problems in new courses in 1993 is that of exchange, and the solving tools of ratio problems are the graph of ratio line. Owing to the operation of lineal graph, we can grasp the relationship of radio to further the activity meaning of transference.

2.3 Basis of System Establishment

The system is a learning environment in the internet, adopting three-tier client/server system architecture, namely adding a layer of Service Server to the original structure of two -tier client/server system architecture. In the three-tier client/server system architecture, the management part of learning data is in the charge of Database Server, Web Server assumes the responsibility for teaching; whereas the client user is carried on by all kinds of learning activities through browser.

3 Simulation of Networked Constructive Pedagogy

In order to grasp the "route difference" of the students' mature concept, the system must recognize clearly how the students think about the problems and how they solve the problems so as to adjust the next activity according to the students' thought and to help children clarify the concepts by using the communication of solving the problems and mode of discussion, so the learner's mathematics knowledge can be upheld accordingly[4,6]. Thus, the system designs operation tool table (as in Figure 1), in which all sorts of tools represent various modes of thought. The students have to utilize these tools to solve the problems; owing to the different tools, the system can grasp the students' process of solving the problems and thought. The flowchart of teaching in this system (as in Figure 2) starts with posing the problems as far as the pedagogic process of any problem, then it is up to the children to decide if they need to be provided clues or graphic emblems to help comprehend the messages of the problems. If necessary, the system has to check out the problems of the same lineal graph as number of ratio problems from database of "ratio lineal graph" and the lineal emblem (as in Figure 3); if the students have comprehended the messages of the problems, enter the students' solving the problems. The students solve the problems with all sorts of tools in tool table; then the system judge the mode of solving by the difference of thought of tools• strategy 1, strategy 2,. :. :Different types of solving enter various tableau, and ask the students explicate the process of solving. The system designs some problems according to the types of solving, helping the students reflect. Through the issue and clarification, the spirit of "mode of communication in the process of solving" would come true. After reflecting the process of solving, the students can choose to study and learn the virtual students' other ways or discuss and communicate with others on the line (as in Figure 4). In case there are students, they can enter discussion room for discussion (as in Figure 5); if there is no student on the line or no one wants to study and learn from the perspectives of others, you can enter the virtual students' various ways and elucidation (as in Figure 6)[5].

4 Architecture and Implementation of System

4.1 Design Environment and Tools

BEST COPY AVAILABLE

This system uses Windows NT server as server as platform. The developing languages include HTML, JavaScript, Active X, ASP (Active Server Page) and so on. ASP is used as the chief way of control and ASP and ODBC (Open Database Connectivity) are also exercised to go with them. The management of teaching material and the users become simplified. As far as the editing course software, Authorware 5 is mainly utilized as the developing tool.

4.2 System flowchart

• 1• Pedagogic situation of networked construction

The flowchart of pedagogic system on the networked construction is manifested in the Figure 7 and the explanation is as follows. The system, through the previous analysis in advance of the class, judges the students' a priori knowledge, by which the system poses the problems, letting the learner solve the problems by themselves. While the students encounter the bottleneck of solving, he can choose the types of the basic lineal graphs or the lineal graphic emblems, and he may discuss and communicate with the students on the line or with virtual students; if the student solve the problem successfully, demand the process of solving and explain those of solving (reflection), then discuss and communicate with the students on the line or with the virtual students. Afterwards, ask the students to record again and explain the process of solving the problem, exploring if the student can use and repeat the strategy of solving in an even simpler and more abstract method, meaning to judge whether the students can comprehend others' methods of solving to proceed the overall assessment finally. Before putting an end to the system, a test about ratio level of thought development as nonroute subject will be exercised on the students, thereby the director will reach a deeper realization of the students' development.

• 2• Database for "student model"• Student model consists mainly of four databases, recording the students' basic data, analyzing their process of solving the problems, the routes of learning and the constructive concepts so as to comprehend their learning state for the reference of posing the problems, by which to understand the students' bottlenecks in learning in order to help them.

• 3• Database of "posing problems of constructive pedagogy"• It saves the teaching content of constructive pedagogy, which contains various types of pedagogic processes, providing the system with sufficient competence to adjust pedagogy positively.

• 4• Database of "questions for tests"• It stores the questions for pretest and posttest. The pretest is used to comprehend the students' acquired knowledge, whereas the backward test, according to the various aims, can be divided into two kinds--formed test and overall test, adopting the proper mode of test.

4.3 Functions of On-line Communication

• 1• Discussion group• This is an open, instead of being a synchronous, discussing place, letting the learner put up the problems on the cooperative notebook while encountering difficulty; other users can answer these problems.

• 2• Discussion room It provides a synchronous and open discussing place, in which the learner can put forth the explanation, suggestion and exchanging viewpoints as to the difficulty aroused in learn ing or as to various strategies for solving the problems.

• 3• On-line call• It belongs to the way of one-to-one real-time communication, providing the user with a brief piece of information immediately, to other users on the line or even the teacher, asking them to undertake discussion in Discussion Room.

4.4 Operation flowchart

When the user enters the system by using browser for the first time, the user has to register in advance (as in Figure 8); by which the system acquires the user's related basic data, so as to proceed to analyze and check. Then take the pretest about background knowledge of learning point to understand if the software content meets the students' need. The system will set the problems according to all types in the problem database (in order to avoid repetition, each type of problems are given at random), and record the state of the learner's study, according to which, the system would produce routes of connection automatically; and it changes the original learning routes by means of the artificial intelligence. It undertakes the proper learning route according to the students' learning state. Later on, whenever the user enters by using browser for the first time, he has to key in the user name and password. The system can proceed to check, and after making sure, the system will continue the previous learning in accordance with the learning record left in advance. When the learner surveys each teaching activity, the system can record the learning process serving as the analysis of learning. The learner can utilize the function of check to understand hie own state of learning. After each learning is finished, the system will demand each learner record the process of solving and then pose the problems again to give the learner the test; according to the learner's answering state, which pedagogic activity will be decided to be carried on actively accordingly.

5 Conclusions

Constructive learning theory will be developed far better if it is carried on network by constructive pedagogy, because networked learning can provide an excellent environment for discussion, upholding the convenience for communication; networked learning can attend to the individual difference, because each student is a leading role. The learner can control the progress of learning by himself, achieving the suitable learning. Networked learning the students' social circles of interaction become larger, not confined to the group of his own class. However, if the real situation by simulation can be added, it is believed that it will draw much attention from students' learning, promoting the learning effect.

References

[1] The seminar ofTaiwan Elementary Teachers .• 1996• .•Teacher Handbook of Experimental Textbook inMathematicsof Elementary School, Volume 9.

[2] Chu-Tsun Chen. (1998). "The Equal Relationship and Lineal Graph", Collected Issue of Elementary Education. Taipei • The seminar of Taiwan Elementary Teachers .

[3] Ning, Tzyh-chiang,.(1993)."Spirit and Innovative Trend ofNew Course in Mathematics for Elementary Education --Seen from Perspective of Constructivism", Scholarly Magazine for Scientific Education, Vol. 1 No. 1, pp. 101-108.

[4] Dalgarno, B.• 1997• • Constructivist Computer Assisted Learning• Theory and Techniques. WWW. 21 Oct. 1997. Available• http://services.canberra.edu.au/~barney/articles/ascilite96/paper.htm

[5] Hiltz, S. R.. "Teaching in a Virtual Classroom. 1995 International Conference on Computer Assisted Instruction ICCAI'95 Hsincku, Taiwan". http://it.njit.edu/njIT/Department/CCC/VC/Papers/Teaching.html (1995).

[6] Squires, D. "Can multimedia support constructivist learning? WWW, 21 Oct. 1997. Available" http://www.spirit.net.au/ACEC96/papers/squir.htm(1997).

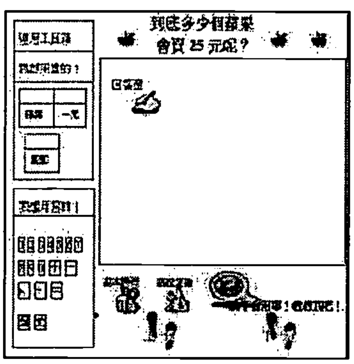


Figure1. Operation tool table.

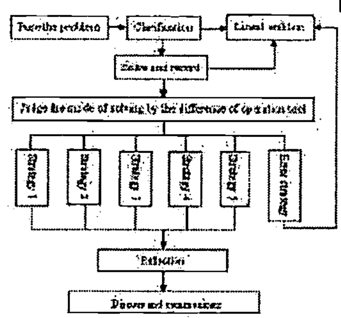


Figure2. The flowchart of teaching in the system.

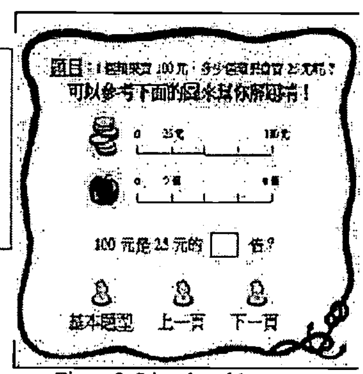


Figure3. Lineal emblem.

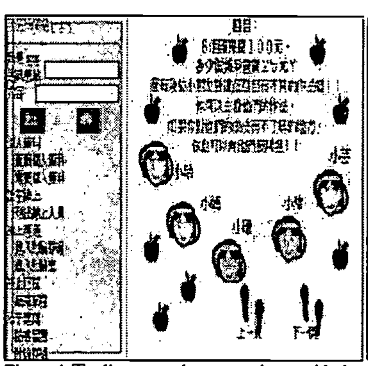


Figure4. To discuss and communicate with the virtual students or on-line students.

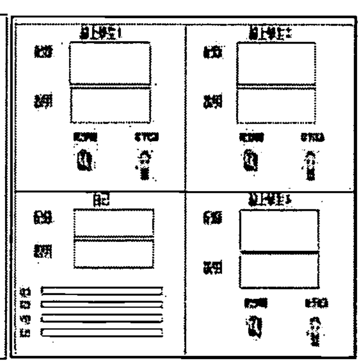


Figure5. The room for discussion.

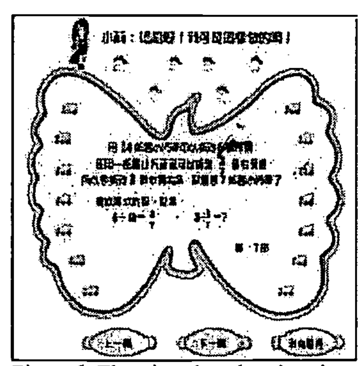


Figure6. The virtual students' various strategies.

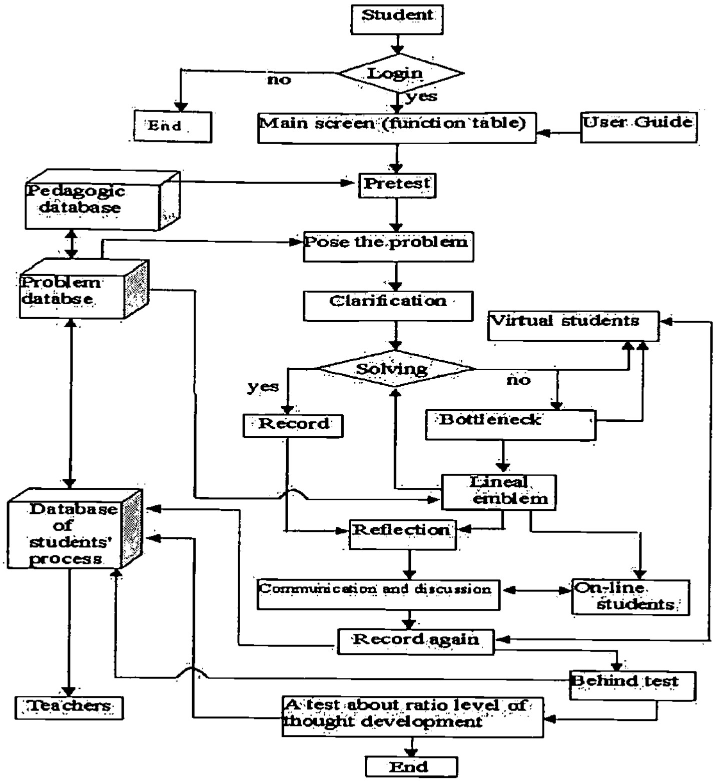


Figure 7. System flowchart.

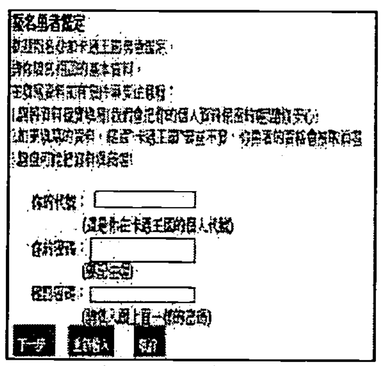


Figure8. Registration.

Online ESL Learning: An Authentic Contact

Yu-Chih Doris Shih* and Lauren Cifuentes**
**Department of Educational Curriculum & Instruction, Texas A&M University*
4205 Boyett St., #C, College Station, TX 77801, USA
E-mail: dorisshih@hotmail.com
*** Department of Educational Psychology, Texas A&M University*
College Station, TX77843, USA
E-mail: laurenc@tamu.edu

As communication via telecommunications become easier, learning through online technologies is made possible. In a telecommunications project among US preservice teachers and Taiwanese English as a Second Language learners, Taiwanese students practiced English language and discussed cultural information with US partners who served as online tutors. Data revealed that Taiwanese ESL learners perceived online learning of English language and American culture to be valuable for its authenticity. Instructions on intercultural communication skills were found to be necessary prior to the connection in order to help eliminate misunderstandings between participants of two countries. The success of online learning depended on several factors such as participants' motivation, participants' attitudes, technology, preparation, and support services. Furthermore, Taiwanese learners who had successful experiences applied ten strategies to their ESL learning. These strategies were employed during a circular process of online learning.

Keywords: **ESL, Online Learning, Telecommunications, Intercultural Computer-Mediated Communications**

1 Introduction

The purpose of this research was to investigate a telecommunications project for Taiwanese students to learn the English language and acquire cultural information through online technologies. Preservice teachers (PSTs) at a state university in the United States worked with Taiwanese learners of English as a Second Language (ESL) at a Taiwanese university. The goal of the research was to study intercultural online learning.

In Taiwan, many scholars have been discussing the need for educational reform and change of instructional methods [7][36]. One change under consideration is increased use of online instruction. Taiwanese researchers suggested that the educational reform should include the adoption of methods proposed in the West (i.e., the United States, Great Britain, Australia, and other English-speaking countries), such as involving students in active learning, teaching critical thinking skills, and incorporating individualized instruction [4][25]. Harasim (1990) and Owston (1997) believed that instruction could be enhanced by online teaching. They have stated that online instruction allows for active learning, idea generating, idea linking, and idea structuring as well as helps the students to develop skills in critical thinking and problem solving. Individualized instruction is supported because both synchronous and asynchronous modes of instruction are workable through technologies.

When online teaching is used as a language instructional method, it remedies Taiwan's geographical isolation as an island and provides opportunities for ESL learners to communicate in an authentic English environment. Successful second language (L2) learning includes not only knowing the linguistic features of the language but also understanding the cultural concepts [14]. Sayers and Brown (1987) remarked, "foreign language students need authentic contacts with native speakers and much practice in a range of language skills -- including reading and writing -- if they are to develop cultural awareness and communicative competence" (p. 23). L2 learners learn language and culture if instruction is facilitated by supportive individualized learning activities [13]. These activities must address the learner's current language level (Krashen's stage of i) and the level beyond the present language and literacy capacities (Krashen's stage of i + 1) [21]. Telecommunications can help overcome the limitations of Taiwanese isolation by providing for supportive and authentic language instruction.

2 Literature Review

Learning through telecommunications has evolved during the 1990s in the West and has proved to be successful [1][8]. To bring more applications into Taiwan, we need to first explore Taiwanese students' needs and attitudes in the use of such technology. Some scholars stated that Asian students employ different learning strategies than students in the West [17][32]. Cheng (1980) pointed out that the educational system in Taiwan has adopted many different educational methods developed in the West; however, utilization has been non-systematic and inappropriate for societal needs in Taiwan. Furthermore, Stewart (1985) and Dooley (1995) noted that the applications of educational technology in other countries besides the United States may be unsuitable because of cultural non-transferability. For instance, other cultures may value a different set of learning and teaching modes when compared to the United States, or they may have insufficient equipment for advanced technological applications. Taiwanese scholars have also urged that future investigations must be done specifically on distance-learning courses in Taiwan [6][37]. Therefore, close examination must be carried out prior to fully adopting new telecommunication technologies as learning tools in Taiwan.

As technology advances, communication over a distance and across cultures becomes easier and inevitable. However, very little can be found in the literature that addresses issues of online intercultural communication and the design considerations that would enhance such interaction. Lee (1999) urged designers and instructors of computer-based instruction to take cultural issues into consideration when developing learning environments and technology integration within curricula. Caution must be taken, especially when intercultural contacts occur in an online learning context, because communicators may not be who they seem to be online [28].

Collis and Remmers (1997) pointed out that to allow successful online cross-cultural contact, at least four issues have to be taken into consideration: communication and interaction, language, content, and representation form. First, communication and interaction are easily misinterpreted across cultures. According to the two researchers, more communication and interaction are not necessarily better than less, and well-structured communication may be preferable for wider audiences. Second, because language includes verbal and nonverbal cultural communication, those developing cross-cultural online instruction must be sensitive to cultural differences in communication styles. Third, designers must choose cross-cultural course content. Last, visuals can overcome problems associated with text-based language. However, one must be sensitive to cultural differences in the acceptability and interpretability of various aspects of visualization.

Research on online connections has been conducted in many areas during this decade. Projects connecting students with teachers or other students in multiple locations were implemented in many subject areas such as science [22], history [3], teaching [27], and language arts [35]. Similar projects in the area of foreign language learning are found in the teaching of Portuguese [20], Russian [30], Spanish [24], and ESL [19][33]. The results of these studies mainly stated how the participants at different sites benefited from the connection in increased technical competence, personal development, language improvement, and more meaningful cultural exchanges. No research has been found that explores the learning strategies used by students while learning a L2 online and the issues encountered during their online intercultural communications.

3 Purposes and Research Questions

There were three purposes of this study: first, understanding the Taiwanese ESL learners' perceptions of learning through distance technologies; second, exploring issues related to online intercultural communication; and third, identifying the learning strategies the Taiwanese learners employed during distance learning to accomplish the acquisition of ESL and understanding of American culture. The three research questions guided the study were:

(1) How do ESL learners in Taiwan perceive language acquisition and cultural understanding via distance learning technologies after the experience?
(2) What intercultural phenomena can be observed in online learning for Taiwanese students?
(3) What online learning strategies do the Taiwanese use while learning the English language and learning about American culture?

4 Method

This study employed a qualitative research design. This design enabled the researcher to inquire, comprehend, and describe the experiencing world of the participants and the meaning of these experiences [2][26].

4.1 Participants

The project involved students in two different countries: US and Taiwan. There were 40 PSTs in the United States who took either *EDTC 305: Instructional Technology: Theory and Practice* or *INST 462: Language Acquisition and Development* at a state university. These were PSTs being prepared to teach English, ESL, political science, and history at the elementary or secondary level. The same number of participants in Taiwan were students who study in the Department of English Language and Literature at a university in Taipei, Taiwan. They were members of *English Composition and Conversation* classes at either sophomore or junior levels. The US and Taiwanese students participated in this research because their instructors included this online connection project as part of their course requirement. The participants in the United States ranged from the ages of 20 to 22, while the students in Taiwan ranged from the ages of 19 to 20.

In addition, the three professors in Taiwan whose students were project participants were also involved as research subjects. They were interviewed by the researcher in regard to their students' perceptions of online experiences, students' improvement in the English language as well as other types of knowledge through the connection.

4.2 Procedures

To carry out the study, US PSTs corresponded with Taiwanese university-level ESL learners for ten weeks. These PSTs served as tutors of the English language and American culture. The participants in both countries were matched one-on-one randomly prior to the connection. They were also given instructions and orientations on the utilization of e-mail systems and on online learning/teaching. The PSTs were provided with a lecture, discussion, supportive readings, example tutorial correspondences, and a web site of resources. The web site included a downloadable lecture about online learning, the expected online correspondence process guidelines, a midterm survey, sample correspondence, and previous participants' reflections (http://www.coe.tamu.edu/~lcifuent/classes/edtc305/online.htm). They also read on topics such as effective facilitation of computer conferencing [9], computer-mediated communication [18], interactivity in online environments [15], online teaching strategies [8], and cultural differences in teaching and learning [17].

Similarly, the students in Taiwan were supplied with an orientation where the project is introduced to them along with rules and regulations. Sample correspondence, results of previous connections, and suggestions for online learning and discussion topics were presented at their departmental website (http://www.eng.fju.edu.tw/cultural_connections.htm).

Every participant received a welcome letter to encourage them to open themselves up to this new experience. The PSTs were given a rubric with expected number grades to help them accomplish the requirements for their part of the connection. The Taiwanese students initiated the connection by sending out their first e-mail message to their US partners. The US PSTs analyzed their student's language level and started to instruct him or her according to that level through e-mail.

Mid-way during the ten-week connection, the PSTs were asked to fill out an online midterm survey. In Taiwan, the students submitted a brief report to their instructors every two weeks to keep track of their connection progresses.

At the end of the connection, the PSTs and their Taiwanese students filled out a post-connection survey. The PSTs also handed in all of their e-mail printouts and personal journals that reflected their online teaching and learning experiences. Similarly, the Taiwanese students handed in their final reports to their Taiwanese instructors. Two weeks after the end of the connection, the researcher traveled to Taiwan to conduct interviews with 12 Taiwanese students and the three Taiwanese professors. The interviews included open-ended questions.

4.3 Data Collection and Analysis

There were eight data sources: (a) printouts of correspondence; (b) the PSTs' midterm survey; (c) the PSTs' post-connection survey; (d) the Taiwanese students' post-connection survey; (e) the PSTs' reflective journal entries; (f) the Taiwanese students' final reports; (g) transcripts of the interview with the Taiwanese students; and (h) transcripts of the interview with the Taiwanese professors.

Data analysis in qualitative studies is an ongoing process during the research; it is best done simultaneously with the data collection [26]. Each time data are gathered, information was analyzed using procedures proposed by Emerson, Fretz, and Shaw (1995). The steps included close reading, open coding, writing memos, noting themes and patterns, and focused coding.

5 Results

Data analyses revealed remarkable information on the areas of (a) learner perception, (b) intercultural communication, (c) factors affecting online connection, (d) online learning strategies, and (e) online learning processes. First, this particular group of Taiwanese ESL learners was positive about L2 and cultural learning in an online setting. The results of a post-connection survey showed that participants more or less agreed that (a) E-mail connections have a positive place in ESL classrooms (mean of 3.71); (b) the Web-connection has a positive place in ESL classrooms (mean of 3.51); (c) they would participate in another online connection if given the opportunity (mean of 3.58); and (d) they would suggest their other friends or classmates participate in a similar project (mean of 3.85) (see Table 1). Even though the response to the question "Overall, my connection was successful" was not very high (mean of 3.26), learners who had an unsuccessful connection held positive attitudes toward the project. One student wrote in her final report, "My pal does not respond to me so often. I didn't learn much through this project this semester. But that doesn't mean this project is not good. I hope school brothers or sisters can still have the chance to get in this project."

Table 1. Taiwanese Students' Responses Toward the Online Connection

Questions	M	SD
The **E-mail connection** has a positive place in ESL classrooms.	3.71	0.67
The **Web-board connection** has a positive place in ESL classrooms.	3.51	1.50
I would participate in another online connection if given the opportunity.	3.58	1.13
I would suggest other friends or classmate participate in a similar project.	3.85	0.78
Overall, my connection was successful.	3.26	1.07

Note. Participants responded on a 5-point Likert scale (1= Strongly Disagree; 5 = Strongly Agree). The survey was complete by 37 participants.

Second, intercultural communication issues cannot be ignored. A lot of Taiwanese learners interpreted that their tutors were angry with them when they did not receive messages over a week. In addition, learners read what wasn't intended in the messages. They constantly apologized to the PSTs for being an inconvenience. Several learners ceased active interaction with the PSTs due to these personal interpretations. The Taiwanese professors suggested that acquainting learners with different thinking patterns and expression styles is necessary in future connections.

Third, factors that affected online connections included participants' motivation, attitudes toward each other, participants' fields of experience, frequency and quality of interactions, technology, preparation, and support services (figure 1). Any missing component would hinder the success of the connection. Other resources such as teachers, peers, family members, libraries, and web resources provided extra assistance to the participants. Fourth, during the correspondences, ten learning strategies were found to be used by the learners in their messages. These were paraphrasing, translation, Q&A from tutor to student, Q&A from student to tutor, explanation, elaboration, decision-making, self-reflection, metacognition, and transfer. The learners in the more successful pairs tended to use a variety of the ten strategies.

Finally, data indicated these ESL learners went through a series of processes for successful learning (figure 2). Motivated learners set learning goals for themselves with the PSTs' help. Those who prepared themselves well by finding topics of discussion or information in the libraries, the WWW, and traditional learning environment aimed for frequent and quality interactions via e-mail with the PSTs. After each interaction, a review period prompted learners for more interactions. Learners who went through these stages concluded that they had learnt new information and increased their confidence in using English reading and writing skills. Needless to say, this result increased their motivation to learn and thus encouraged the start of another learning cycle.

6 Discussions and Conclusion

This study is significant to both distance-learning educators and language-learning educators. There are at least three reasons for this significance. First, the study provides insights for distance educators, both for those in Taiwan and for those in other countries who have Taiwanese students enrolled in courses that are delivered via telecommunications. The results of the study help these instructors to further understand Taiwanese students' positive perceptions of L2 learning through online technologies, identify suitable conditions and environment for these learners, and decide the extent to which this mode of instruction is applicable to students from this cultural background.

Second, the online intercultural communications issues explored in this study assist telecommunications users with more effective communication. They help users become aware of and anticipate problems when coming into contact with people of other cultures via distance technologies. Even without using online technologies, intercultural communication is already complex. Therefore, interaction may be hindered further when technology is the transmission medium. Understanding the barriers and facilitators of online intercultural communication leads to better and more successful intercultural interactions.

Third, the identified ten online learning strategies and online learning processes will add to the literature on language learning and teaching. Such research is in demand because ESL programs in the United States are planning to deliver more ESL courses to foreign countries via distance learning technologies.

In summary, most Taiwanese ESL learners had a positive experience with the online connection. The few connections that failed were due to lack of participants' response, lack of participants' motivation, and technical failure. Nevertheless, providing L2 instruction to learners over cyberspace is a method that should not be ignored. Learners need to be prepared with adequate intercultural communication skills and online learning strategies.

Follow-up investigation of online ESL acquisition might include specific amount of improvement on learners' writings and learning via synchronous technologies such as chats, interactive videoconferences, and desktop videoconferences.

References

[1] Bates, A. W., "Technology, open learning and distance education", Routledge (1995)
[2] Bogdan, R. C., & Biklen, S. N., "Qualitative research in education: An introduction to theory and methods", Allyn & Bacon, 3rd ed (1998).
[3] Butler, W. M., "Writing to learn history on-line", The Clearing House, Vol. 69, No. 1, pp. 17-19 (1995)
[4] Chang, H-J., "Trends of instructional methods", Social Change and Educational Development, pp. 483-522, Taiwan Bookstore (1991)

[5] Cheng, S-H., "Chinese contemporary history of education", San-Ming bookstore (1980)
[6] Chou, C., Chou, J., & Tyan, N. N., "An exploratory study of Internet addiction, usage and communication pleasure - The Taiwan's case", International Journal of Educational Telecommunications, Vol. 5, No. 1, pp. 47-63 (1999)
[7] Chu, C-C., "Social change and current educational system", Social Change and Educational Development pp. 37-65, Taiwan Bookstore (1991)
[8] Cifuentes, L., & Shih, Y-C D., "Teaching and learning online: A collaboration between U.S. and Taiwanese students", Journal of Research on Computing in Education, Manuscript accepted for publication (2000)
[9] Cifuentes, L., Murphy, K.L., Segur, R., & Kodali, S., "Design considerations for computer conferences", Journal of Research on Computing in Education, Vol. 30, No. 2, pp.172-195 (1997)
[10] Collis, B. & Remmers, E., "The World Wide Web in education: Issues related to cross-cultural communication and interaction", Web-based instruction, pp. 85-92, Educational Technology Publications (1997)
[11] Dooley, L. M., "Problems and issues in distance learning using interactive video between the U.S. and selected African countries", International Journal of Educational Telecommunications, Vol. 1, No. 1, pp. 93-104 (1995)
[12] Emerson, R. M., Fretz, R. I., & Shaw, L. L., "Writing ethnographic fieldnotes", The University of Chicago Press (1995)
[13] Enright, D. S., "Supporting children's English language development in grade-level and language classrooms", Teaching English as a Second or Foreign Language, pp. 386-402, Heinle & Heinle (1991)
[14] Fantini, A. E., "Bilingualism: Exploring language and culture", Language, culture and cognition, pp. 110-119, Multilingual Matters (1981)
[15] Gunawardena, C. N., "Changing faculty roles for audiographics and on-line teaching", The American Journal of Distance Education, Vol. 6, No. 3, pp. 58-71 (1992)
[16] Harasim, L. M., "Online education: An environment for collaboration and intellectual amplification", On line Education Perspectives on a New Environment, pp. 39-64, Praeger (1990)
[17] Hofstede, G., "Cultural differences in teaching and learning", International Journal of Intercultural Relations, Vol. 10, pp. 301-320 (1986)
[18] Jonassen, D. H., Davidson, M., Collins, M., Campbell, J., & Haag, B. B., "Constructivism and computer-mediated communication in distance education", American Journal of Distance Education, Vol. 9, No. 2, pp. 7-25 (1995)
[19] Kamhi-Stein, L., "Promoting EFL teacher development through e-mail instruction", Computer-Assisted English Language Learning Journal, Vol 7, No. 4, pp. 14-19 (1997)
[20] Kelm, O. R., "The use of synchronous computer network in second language instruction: A preliminary report", Foreign Language Annals, Vol. 25, No. 5, pp. 441-454 (1992)
[21] Krashen, S. D., "The fundamental pedagogical principle in second language teaching", Studio Linguistica, Vol. 35, No. 1-2, pp. 51-70 (1981)
[22] LeBaron, J., & Teichmaun, V., "KITES: A middle school environmental science telelink to West Germany", Educational Technology, Vol. 29, No. 6, pp. 51-53 (1989)
[23] Lee, C. D., "Towards a framework for culturally responsive design in multimedia computer environments: Cultural modeling as a case", Paper presented at 1999 American Educational Research Association Convention at Montreal, Canada (1999)
[24] Leh, A. S., "Electronic mail in foreign language learning: Communication and culture", ERIC Document Reproduction Service No. ED409851, Association for Educational Communications and Technology (1997)
[25] Lin, S-C., "Current social change and instructional reformation in Taiwan", Social Change and Educational Development, pp. 459-482, Taiwan Bookstore (1991)
[26] Lincoln, Y. & Guba, E., "Naturalistic inquiry", Sage (1985)
[27] Lowry, M., Koneman, P., Osman-Jouchoux, R., & Wilson, B., "Electronic discussion groups: Using E-mail as an instructional strategy", Tech Trends, Vol. 39, No. 2, pp. 22-24 (1994)
[28] Newbold, W. W., "Transactional theory", http://www.bsu.edu/classes/newbold/htx/theory.htm (accessed on July 20, 1999).
[29] Owston, R. D., "The World Wide Web: A technology to enhance teaching and learning?" Educational Researcher, Vol. 26, No. 2, pp. 27-33 (1997)
[30] Samsonov, P., "Russian translation via e-mail", IALL Journal of Language Learning Technologies, Vol. 30, No. 3, pp. 39-42 (1998)

[31] Sayers, D., & Brown, K., "Bilingual education and telecommunications: A perfect fit", The Computing Teacher, Vol 15, No. 8, pp. 23-24 (1987)
[32] Smith, P. J. & Smith, S. N., "Differences between Chinese and Australian students: Some implications for distance educators", Distance Education, Vol. 20, No. 1, pp. 64-80 (1999)
[33] Soh, B-L, & Soon, Y-P., "English by e-mail: Creating a global classroom via the medium of computer technology", ELT Journal, Vol. 45, No. 4, pp. 187-292 (1991)
[34] Stewart, A., "Appropriate educational technology: Does 'appropriateness' have implications for the theoretical framework of educational technology?" Educational Communication and Technology, Vol. 33, No. 1, pp. 58-65 (1985)
[35] Traw, R., "School/university collaboration via e-mail: A unique approach to teaching reading and language arts", Tech Trends, Vol. 39, No. 2, pp. 28-31 (1994)
[36] Wang, C-Y., "Social science education in social change", Social Change and Educational Development, pp. 147-164, Taiwan Bookstore (1991)
[37] Young, S., "A field study of the implementation of a synchronous distance course with asynchronous Internet-supported telecommunications technologies in Taiwan, R. O. C.", International Journal of Educational Telecommunication, Vol. 5, No. 2, pp. 111-125 (1999)

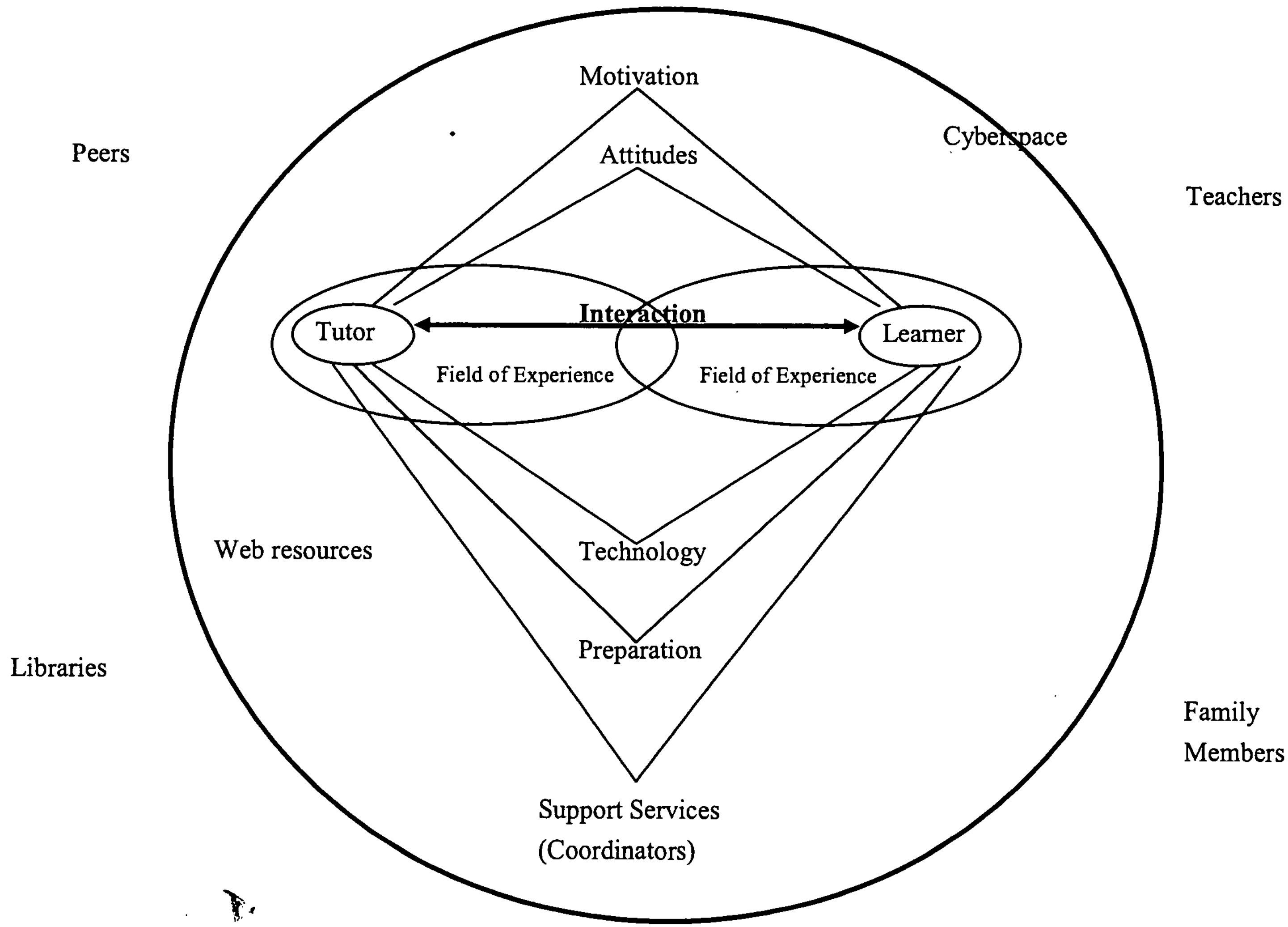


Figure 1. Factors Affecting Online Connections

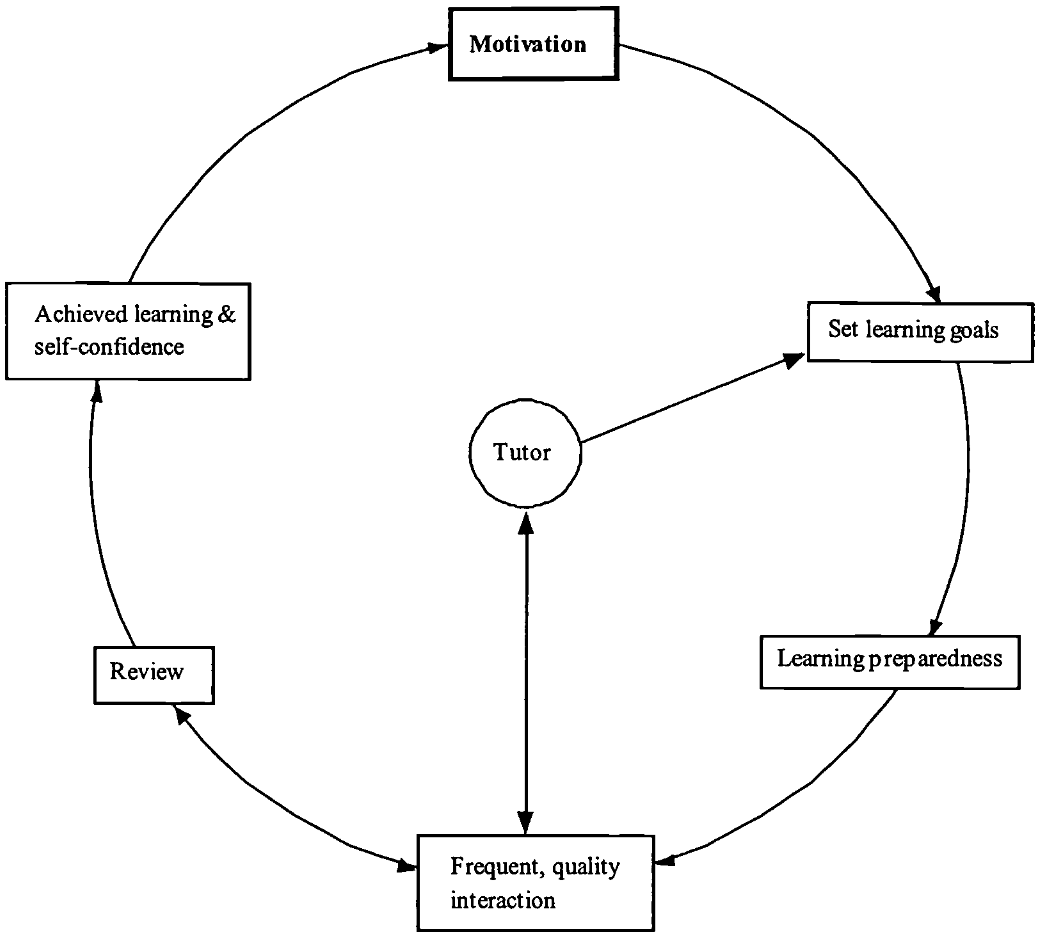


Figure 2. Online Learning Processes in the United States-Taiwan Connection.

Organization of the introductory and motivational stage of activity in a computer tutoring system

Gennadiy Atanov and Vladimir Laktiushin
Donetsk Institute of Social Education; DISO, Donetsk, 83000, Ukraine;
E-mail: atanov@dongu.donetsk.ua

1 The activity approach in education

From the point of view of modern didactics, the final aim of instruction is not gaining knowledge but forming the way of acting being realized via skills [3]. It may be only done in the process of activity, namely learning activity. In this sense, any instructional process represents guidance, operative management of learning activity. It is management that is mechanism of teaching but not passing knowledge. Learning activity is a product of teaching because it is the aim of teaching. Knowledge is necessary, so far as the way of acting is worked out by means of operating with knowledge. On the other hand, knowledge is formed only in the process of activity []. Thus content of teaching includes subject to mastering and knowledge on which based this activity. From the point of view of organization, activity has three stages: 1) of introductory and motivation, 2) of operation and cognition, 3) of control and estimation.

An action is a unit of activity. The way of acting is a system of operations that provides solving of problems of a definite kind. The way of acting has three functional parts: (1) orientating one that provides preparation the student to activity; (2) executive one providing transformation of the objects of activity; (3) control one that provides check-up of rightness solving the problems and comparison the factual products of activity with desired ones, that is, the aim of activity [2].

Many authors of computer technologies attribute them to the ones based on activity (learning by doing) only because of work specificity with a computer but not because they realize principles of the theory of activity. In accordance with it, projecting a computer tutoring system means, first of all, projecting learning activity, not knowledge. Knowledge is projected after actions. Only on determining actions, it is possible to pick out knowledge providing formation of these actions.

Development of activity my be schematically represented in the following way: *need – motive – aim – subaims – problems – subproblems – actions – operations – product.* The introductory and motivation stage of activity, especially for learning activity, is the most important one because it is the initial stage of activity. It is called to settle questions of "lead-in" of students in activity, their adaptation to future activity, that is, questions of orienting and motivation.

In the orientating part of the way of acting, they pick out two components (Mashbits, 1988). The first one – general orienting – provides picking out those properties and qualities of the objects of activity that are essential for their transformation. The second one – orienting for the executive part – provides working out a plan of activity. Only the executive part of the way of acting providing immediate transformation of the objects is the direct product of the traditional teaching. There is the only way to do this – solving problems.

2 Organization of the introductory and motivational stage

The introductory and motivational stage plays an important psychological and didactical role in teaching in general; while using a computer, its role increases repeatedly. Nevertheless, to meet a tutoring system in which due attention would spare to this stage is a very rare thing. We organized it in tutoring systems in physics [1]. The tasks of the introductory and motivational are realization and understanding by the students: 1) aims and problems of the system; 2) physical character of processes and phenomena, as well as principles of operation of the installations that are the subjects of the system's activity; (3) knowledge necessary to reach the aim put the system. According to the theory of activity, it is operating with this knowledge that leads to forming first skills necessary for solving a particular problem and then the way of acting in aggregate.

The approach of problems that is realized in our systems is based on solving a separate problem whose complication increases that of problems being solved usually. This approach is more preferable from the point of view of activity. Firstly, it allows easily and effective organize learning activity and, secondly, it gains essentially in motivation as presupposes achievement of a practically significant aim. In many systems, this aim is even submitted in their titles, for example, "Hit the Target", "Rescue the Friends", "Render Harmless of the mine", "Determine the material". It is a very effective means to increase motivation, as the student becomes a subject of activity, the main acting person of the events expanded. Various methods of realization of this stage are used, for example, mimicking processes and phenomena, "assembling" installations from their separate parts, discussion their purposes and peculiarities of operating the installations, test tasks of the closed and open types, ones for accordance and ones for correct sequence.

Let us consider as an example systems "Internal Combustion Engine". The aim of it is determination of power and efficiency of an engine in accordance with its constructive parameters. As one can see, the title of this system does not promote increase of motivation because of the lack of the personal orientation. This is achieved by another method. A list of cars with demonstration of their outward appearance is offered to students. Students choose a car that they like and then carry out calculations for the engine of their own car.

Let us describe in what way a test task for accordance is realized in these systems. A "dumb" scheme of an installation without pointers of its component parts is shown on the screen. A list of its component part is placed next to it. Activity of students consists in the following. Separate elements of the scheme are pointed sequentially by chance, and students have to put for each element of the scheme corresponding one of the list. If the title of the pointed component part is determined correctly, another element is pointed, and so on. The determined parts acquire their numbers, and as the result, the "dumb" scheme is transformed into a "live" one. In such a way an orienting support of activity is created.

Further development of the introductory and motivation stage in the system above proceeds in the following way. The system demonstrates work of the engine during a whole cycle with replacement of the piston, opening and closing the exhaust and inlet valves, ignition of a air and gas mixture. Students may start such a demonstration several times independently. Now students see interaction of the component parts of the engine already well known to them, now they unit in their consciousness not simply mechanically but functionally reflecting physics of the processes occurring in the engine.

Subsequent deepening of orienting passes by discussion of what students have seen. It is very convenient to use the so-called active prompts with this purpose. Active prompt is built as a test task of the open type. It represents a phrase, in which a keyword is missed; this word has to be entered by students. If students do not know it, they may address to the system for help, and it will show this word on the screen. In order to keep the students' active position, the system offer the same active prompt repeatedly, and students must enter this already well known word themselves. Examples of active prompts are phrases: "The inlet valve is open when the piston goes down(wards)", "The spark springs up when the piston is at the upper extreme position" (the missed words are in italic). The main thing here consists in not completeness of these tasks but in importance of ascertaining these (and other) facts for forming the orienting base of the future activity.

The elements of the introductory and motivational stage are distributed throughout a system, their task is to prepare students to performing subsequent separate actions. If, for example, there is a necessity of using some formula, it is very convenient to remind it by a test task of the closed type. Students are offered several formulas, and they have to choose the necessary one. If students make mistakes, a short dialogue should be organized so that students could understand the nature of the mistakes. Then the task should be given again, the search of the answer becoming more sensitive. And the answer will be obtained without fail.

If the development of an action demands using exact wording (of laws, principles, theorems, definitions of concepts, and so on), it is expediently to employ a test task for the correct sequence. In the chosen wording, all the words are missed by chance (this does the system), and the task of students consists in that the words must be arranged correctly with the help of the mouse. It is a very creative and constructive work, it thrills, in the first place, because the sense appears little by little. Everyone can reach the sense even if he/she is not familiar with it at all.

References

1. Atanov, G.A., Kandrashin,G.V., Laktiushin,V.V. Computer Tutoring Systems for Science Education Based on the Activity Approach. New Media and Telematic Technologies for Education in Eastern European Countries. Eds. P.Kommers, A.Dovgiallo, V.Petrushin, P.Brusilovsky. Enshede: Tvente University Press. Pp. 75-79. (1997)
2. Gal'perin, P.Ya. Psychology of Thinking and Doctrine about Step by Step Forming Mental Actions. Moscow. (1966) (in Russian).
3. Mashbits,E. Psychological and Pedagogical Problems of Computating in Education. Moscow, Pedagogika (1988) (in Russian).

Reflections on Educational Technology from Female Asian Faculty's (FAF) Perspectives

Doris Lee*, Amy S.C. Leh, Mei-Yan Lu*** and Mei-Yau Shih******
**Pennsylvania State University -Great Valley, School of Graduate Professional Studies 30 East Swedesford Rd., Malvern, PA 19355, USA, YDL1@psu.edu*
***Instructional Technology, California State University, San Bernardino, San Bernardino, CA 92407, USA, aleh@csusb.edu*
****Instructional Technology, San Jose State University, San Jose, California 95192-0076, USA, meiyan@email.sjsu.edu*
*****Center For Teaching, University of Massachusetts Amherst, Amherst, MA 01003, USA, mshih@acad.umass.edu*

Four panelists in this panel session will briefly present their perspectives on how the instructional technology field has influenced current Faculty development, Corporate training, In-Service teacher education, and Pre-service teacher education. Presenters will address their challenges as female Asian faculty in Faculty development, Corporate training, In-Service teacher education, and Pre-service teacher education. Suggestions and solutions will be discussed during the panel session.

Keywords: **Facnlty development, Corporate training, In-Service teacher edncation, Pre-service teacher education, reflection, and perspectives**

Introduction

Each panelist will offer their unique perspectives in the field of instructional technology. Our focus questions are:

1) Has instructional technology field influenced current:
* Faculty development (Dr. Mei-Yau Shih)
* Corporate training (Dr. Doris Lee)
* In-Service teacher education (Dr. Amy S. C. Leh)
* Pre-service teacher education (Dr. Mei-Yan Lu)

2) What are the challenges do female minority faculty encounter in:
* Faculty development (Dr. Mei-Yau Shih)
* Corporate training (Dr. Doris Lee)
* In-Service teacher education (Dr. Amy S.C. Leh)
* Pre-service teacher education (Dr. Mei-Yan Lu)

Reflections on Educational Technology from Female Asian Faculty's (FAF) perspectives on In-service teacher education (Dr. Amy S.C. Leh)

Technology advancement is altering our society and our education. New technology standards grant opportunities, and policy reflect the change currently happening in our education. In September of 1997, the National Council for Accreditation of Teacher Education (NCATE) released a report addressing the importance of integrating technology into instruction. New technology standards clearly indicate that teachers must be competent of using technology in their teaching. Moreover, the Department of Education (DOE) has spent millions of dollars on grants to support teachers' training. The grants have brought many university faculty members, school district administrators, and school teachers together to work on the task—technology integration. In the annual conference of Association for the Advancement of Computing in Education (AACE) 2000, Tom Carrell, director of PT3 grants addressed the influence of technology on our education and the need for organizational change. Some schools, for example, decided to only hire teachers who are competent of the use of technology.

At present, training teachers the use of technology has become a strong nation-wide movement and in-service teachers are expected to become technology literate through in-service training. The strong demand of teachers' training has invited many international scholars to participate in the movement of training US teachers the use of technology. The international scholars were mostly born outside of the United States, came to the USA for their higher education, e.g. Ph.D. degree, and are currently university faculty members at US universities.

The international faculty' participation brought new blood and tremendous strength into US in-service teacher education due to their educational experiences in both the USA and their native countries. Their experience with both educational systems allows them to compare how students learn in two different nations and to employ the strengths of each nation in the USA. For example, how an Asian student learns math is different from how a student in the USA. Asian students' math practice involves word problems (concepts) while the USA students' practice focuses on page after page calculation. An Asian Mathematics faculty, who was differently trained, might use a variety of effective teaching strategies due to the exposure to different ways of learning. Similarly, international Instructional Technology faculty may provide different perspectives in in-service teachers training. Because they are foreigners in the USA, they encounter challenges, especially international female faculty. Reports show that the percentage of female faculty in higher education is low. Some reports even indicate that they encounter more challenges than male faculty, e.g. in promotion. In this case, international female faculty would be minority within a minority and consequently encounter greater challenges. Below are examples of challenges:

"I felt that my viewpoints were not valued." (from an international male faculty)

"I felt that I was transparent in many meetings. They didn't seem to see my presence." (from an international female faculty)

"She [an international female faculty] couldn't get tenured because she was a foreigner." (from a US female faculty)

"You [an international female faculty] are double minority. You're female and foreign..You need to be firm and stand up for yourself." (from a US female faculty)

Reflections on Educational Technology from Female Asian Faculty's (FAF) perspectives on Corporate Teaching (Dr. Doris Lee)

Today, employees in the corporate settings operate in a rapidly changing, high tech environment. Each employee, in order to accommodate the increasingly rapid rate of technology change, must continually re-tool and upgrade his or her skill sets through life-long learning. The delivery medium for life-long learning, most likely, will use instructional technologies. Instructional technologies refers to computer technologies that can integrate texts, graphics, audio, video, animation, or film clips for the creation of instructional or training packages. Recently, instructional technology also includes the use of the World Wide Web, WWW, in which instruction can be delivered over public or private computer networks and can be displayed by a web browser. Dr. Doris Lee, one of the panelists has taught corporate trainers for more than 10 years in the areas of instructional technologies and design and development of computer-based and web-based training. Based on such an experience, Dr. Lee's discussion in this panel will focus on the impact that the instructional technologies have on corporate training, and what are the challenges and perspectives that she faces as a female instructor for corporate trainers. Below details her experiences and views on these topics.

Generally, most corporations believe that the use of instructional technologies would provide an additional tool to the face-to-face training, can be designed to integrate multiple options including video, audio, and text to accommodate employees' preferred learning styles, and is valuable in providing consistent and current training to employees. In addition, the use of instructional technologies to deliver training can be time and place independent and therefore, costs associated with employees' travel and classroom training can be reduced. However, some companies express concerns in using instructional technologies. These concerns include employees' lack of computer and/or Internet skills, the design and development issues, and the software and hardware limitations.

To convince my students, who are corporate trainers, to consider all the important organizational factors and design issues while using instructional technologies is the biggest challenge. Most of the corporate trainers are female and work in a male-dominate environment. It is imperative for a female faculty to emphasize the importance of front-end analysis even if the analysis is not desirable by their male supervisors. When a company is considering using instructional technologies, a female trainer should never feel intimated to ask important questions including human, machine and political readiness. Questions such as, are the employees comfortable with computers and are they ready to learn, need to be asked. Next, technology readiness is another factor. Hardware, software, and the availability of a technical support staff are some examples of the areas that need to be evaluated. Also, financial readiness pertains to budgeting for upgrades to hardware and software, the purchase of courseware, and developing staff. Plus, political readiness concerns the support of instructional technologies by upper management, middle management, employees, and the training department. Finally, skill readiness looks at whether the staff involved with supporting and developing the training has the skills necessary to do so.

Reflection on educational technology from female Asian faculty's (FAF) perspectives on Pre-service Education (Dr. Mei-Yan Lu)

Educational technology has played a major role in influencing pre-service education. For example, In the 60s, 70s, it was the audio-visual education. In the 80s it was computer assisted instruction (CAI), BASIC programming and Logo programming. In the 90s, it was multimedia, web-based learning.

As a female Asian faculty who has taught in major teacher training Institutes, I would like to share some of the unique challenges for preparing future teachers (per-service teachers) the past 16 years.

Challenge no. 1: Most pre-service teachers are young female white adults. Many of them do not have experiences in working with Asian faculty. For example, a typical K-12 school in San Jose, California, has mainly white teachers/administrators, in many cases, 100% white teachers/administrators while many of their students are from a diverse cultural background. Sometimes, a school student body is from 72 different language and cultural background.

Challenge no. 2: Most teacher preparation institute has mainly white faculty. For example, in the College of Education at San Jose State University which graduate, on the average, 600 credential teachers annually, has about 110 full time faculty. Out of the 110 full time faculty, only 6 are Asian faculty (Chinese, Japanese, and Korean).

Challenge no. 3: Most Asian female faculty are "foreign born'. The fact that we are different can offer unique perspectives to our students and colleagues. However, sometimes, our background and cultural differences can be barriers as well. For example, the accent issue. Some students and faculty complain that Asian faculty have heavy accent. However, they rarely complain the European Born faculty who has heavy European accent. Many times, they found European accent charming, while Asian accent distracting.

Challenge no. 4: The field of educational technology generally does not pay attention to solutions and strategies in designing instruction for audience from diverse cultural background. For example, in 1999 AECT convention, there were only two presentations in the entire conference program addressed the issue of designing for international and diverse cultural audience. As one of the popular instructional media – World Wide Web and distance learning is gaining more attention, we as instructional designers/faculty should pay more attention to the international audience.

My goal is to prepare technologically competent teacher candidates that are also culturally sensitive to work with diverse student population. With this goal in mind, I like to recommend:

1. Increase the representation of diverse student body in the field of educational technology both within the United States and outside of the United States.
2. Recruit more faculty of color. Therefore, students will have opportunity to work with both faculty and students from different cultural background.
3. Look beyond the "accent" issue. The point that I am trying to make is that more of the main stream Americans have no trouble "comprehend" accented English. They just do not like the way it "sound". In addition, people who speak with an accent are capable of speaking more than one language and be able to function effectively in another culture. Why not take their unique experience and learn how to design instruction for an international audience?

4. Encourage more educational technologists to research the cultural issues in designing instruction such as in the area of World Wide Web and distance learning.

Reflections on Educational Technology from Female Asian Faculty's (FAF) perspectives on Faculty Development (Dr. Mei-Yau Shih)

The use of instructional media in the classroom has long been identified as a "fourth revolution" in education (Ashby, 1967). It has the potential to reshape the role of the instructor from a knowledge conveyer to a guide and coach, while students take a more active role in the learning process. No longer are the textbook and instructor the sources of all knowledge; instead, the faculty member becomes the director of the knowledge-access process (Heinich 1996 et al,). Instructional technology refers not only the actual use of technological tools it also stresses the importance of the process of developing overall goals and strategies for enhancing teaching and learning. At its best, technology-based learning can help teachers support a wider range of learning styles, facilitate active learning in the classroom, use faculty time and expertise more effectively, and familiarize students with technology that will be vital for their futures in the world of work.
In our experience, university faculty are both greatly excited and daunted by the promise and power of teaching technologies. Our students have grown up in a "high technology" environment and are well adept at the use of TV, videotape, computers, and the Internet as information exchange tools. Many faculty, on the other hand, struggle to learn new technologies and to see how they might be useful to them as teachers (Shih & Sorcinelli, 2000). . The higher education is encountering the new trends of the changing student body, teaching practices, and the new roles and identities of faculty in universities. It is imperative, therefore, to remains a holistic view while helping faculty develop their technological skills with an understanding of the educational values and systems where the teaching and learning take places.

The perspectives from a foreign born female faculty developer, whose first 20 years of educational training differs massively from the majority of US university faculty on educational technology, reflect not only a personal challenge, they also underscore the important tasks of any faculty develop who serves as the chang agent in helping the transformation of teaching practice with instructional technology. These tasks include, first, effectively represent the instructional technology to faculty to help them see the integration of technology involves more than physical setup and technical support; it requires some curricular modifications and instructional strategy shifts; second, take in the cultural and educational differences in educational systems to design the strategies in energizing faculty and inspiring them trying innovative ways of teaching, and made them conscious about their purposes in the classroom; third, establish credibility and earn trust of the faculty to represent effectively the benefits of using technologies for teaching and learning; forth, remain alert and sensitive to the campus culture to help enhance the collegiality on campus, and maintain a supporting network of "exemplars" who would be eager to take risks and become "mentors" to colleagues who express interest in instructional technologies. Of most importance task as an Asian, female developer working for rising faculty technological skills is to help faculty recognize the diversity in college classroom, to make them conscious of the various student learning styles, ages, genders, race and ethnicity, and digital have' s and have-not' s issues in classroom. Effectively carry out these tasks is the means to the ends to help best researchers use and understand the instructional technologies to become a better and effective teacher in the 21st century.

REFERENCES

[1] Ashby, E., (1967). "Machines, Understanding, and Learning Reflections on Technology in Education." The Graduate Joumal, 7, pp. 359-373.
[2] Heinich, R., Molenda, M., Russell, J. & Smaldino, S. (1996). Instructional Media and Technologies For Learning. 5th Edition. Englewood Cliffs, New Jersey. Prentice-Hall, Inc.
[3] Shih, M. Sorcinelli, M.D.. (2000). "TEACHnology: Linking Teaching and Technology in Faculty Development." To Improve the Academy. V(18). POD Network. Anker Publishing Company, Inc. Bolton, Massachusetts.

Strategies for Searching in the WWW

Meng-Jung Tsai
Center of Teacher Education, Tunghai University
181, Sec. 3, Taichung-Kang Rd., Taichung, Taiwan 407
Tel: +886-4-3590121
Fax: +886-4-3580601
E-mail: mjtsai@mail.thu.edu.tw

Searching information in the WWW effectively and efficiently is an important vehicle for 21st century citizens to become lifelong learners. This study was to identify effective information-seeking strategies by comparing the strategies employed by the Internet novice user and those by the expert user. A searching task followed by an interview were undertaken in order to observe the strategies used by the subjects. Pre-task and post-task surveys were also administered to collect data relating to subjects' background and self-efficacy toward using the Internet. Protocol analysis was used to analyze the verbal data collected in this study. The results showed that the expert and the novice employed different information-searching strategies in the following six aspects: computer self-efficacy, task anxiety, search aids, information processing, concentration, and problem solving.

Keywords: **Searching Strategies, Lifelong Learning, WWW**

1 Introduction

Lifelong learning has been recognized as an important goal of education in the twenty-first century [14]. With increasingly tremendous information to face everyday, searching desired information effectively and efficiently becomes a necessary skill for learning in such an information age [4, 6]. Due to its efficiency and popularity, the World Wide Web (WWW) is becoming a powerful vehicle for reaching the goal of lifelong learning.

However, it seems not easy for Internet novice users to search information effectively and efficiently via the web. For example, disorientation was reported as a problem that the novice explorers might have while navigating within a hyperspace [2]. It was often to lose directions if they were lack of self-conscious in searching motivation, strategies, results, and meanings. Borgman suggested future research to compare novice and expert users' cognitive behaviors while they are doing a specific searching task in order to find the key factor to accomplish the task [1].

Prior research indicated that users' metacognitive ability, orientation conscious, system knowledge, domain knowledge, and system design influenced users' searching strategies while navigating in a hypermedia environment [6, 10]. Users' computer knowledge and information processing skills were particularly emphasized as important factors to determine a successful searching [4]. Except by improving the system design to help users perform self-reflection during the information-seeking process [9, 7], future research was suggested to evaluate the application of metacognitive skills in an Internet-based learning context [4, 5].

According to the literature about metacognitive strategies [12, 16], learners need not only to have self-conscious about their own learning but also have to know what strategies they can use and how to use them in order to enhance their metacognitive abilities. In addition, it is more important for students to know how to learn than what to learn in order to reach the goal of lifelong learning [14]. Teaching students about how to learn has been demonstrated to be effective to improve students' achievement and attitudes in various learning domains [8, 13]. However, little research explored the strategies specifically for searching information in the WWW.

Hill [5] described a conceptual framework for how users formulate and employ information-seeking strategies in open-ended information systems (OEISs), e.g. the Internet. Two stages of information seeking were presented in this model. The first was navigational stage, which included the following processes: purposeful thinking, acting, and system responding. The second was process stage, including evaluation, transformation and integration, and resolution. With limited metacognitive ability and unawareness of computer application skills, novice users tended to suffer information overloading. They often repeated the behaviors which were recognized in the navigational stage, but seldom performed the actions belonged to the process stage. However, experienced users were able to utilize the searching strategies that were recognized in both stages [5]. They also showed how to control and manage their searching process. It seemed that users' self-awareness about their own searching ability, self-reflection, self-control and self-management about their searching process were keys for successfully seeking information on the Internet.

In order to become lifelong learners, all citizens of the next century must know what strategies they can use for searching information effectively and efficiently on the WWW and how to use them. If the Internet is an important vehicle for lifelong learning, then identifying effective WWW searching strategies should be the first step to reach the goal.

2 Purpose

The purpose of this study was to identify effective WWW information-seeking strategies by comparing the strategies used by Internet novice users and experienced users. Therefore, the research question of this study was: What are the differences between the strategies used by Internet novice users and those used by Internet experienced users while searching infomation on the WWW?

3 Methodology

Two in-deep case studies followed by a between-case comparison were used to answer the research question. A college freshman, as an Internet novice user, and a college graduate working at a computer technology company, as an Internet expert user, were volunteered to participate this study. Both subjects were asked to perform a searching task alone through the WWW by using a web browser, Internet Explorer. The goal of the task was to find a freshmen course schedule of a specific department in a large university in Taiwan. The searching processes were both videotaped for observing subjects' searching paths, number of websites visited, and the time spent on each site. During the search, subjects were asked and continuously reminded to perform think-aloud in order to collect verbal information for protocol analysis [3] of their searching strategies. Pencils and blank answer sheets were issued to subjects for taking notes or answers.

Before•searching, a survey was administered to collect subjects' Internet background, including their Internet using history, frequencies of Internet access, Internet access availability at home, Internet courses taken before, and self-efficacy about searching information on the WWW. Right after the searching task, subjects were given another survey to reflect their self-satisfaction toward their performance in the task. Subjects were further interviewed by the researcher if there was a need to clarify on the videotape. Subjects' searching paths, actions, responses, and think-aloud protocols were analyzed for each case and then compared between cases.

4 Results

Comparing the data collected from pre-task and post-task surveys, searching paths, verbal scripts and blank answer sheets, several different characteristics showed between the Internet novice user and expert user. First of all, the expert finished the task and got desired information after visiting 30 in 18 minutes, whereas the novice visited 19 websites in 24 minutes with a blank answer. Except for different searching results between the cases, this also showed that the expert's navigating speed was as about twice as the novice's. In addition, the expert spent less than one minute on each website, whereas the novice spent more than one minutes on five websites. This indicated that the expert processed and evaluated the information shown on computer screen much faster than the novice.

Besides, verbal scripts to complaint about system like "I hate it! It is so slow.." or to critique the website design like "This is a poor website full of redundant information.." showed 9 times during the expert's searching and 0 during the novice's; however, anxiety or worrying responses like "How come I cannot find it.." or " I cannot..I cannot..I just cannot find it.." showed 12 times during the novice's searching but 0 during the expert's. This suggested that the expert was confident to and believed being able to find the desired information; however, the novice users were coping with tremendous amount of anxiety toward reaching the goal of the task. This was concurred with their reflections in pre-task survey about their self-efficacies toward using computer technology.

Furthermore, navigation disorientation and system problems did not happen during the expert's searching process, but happened in the novice's searching process. The novice responses with "I understand it but just don't know where to start.." "How did I get here.." and "Oh! My god. I made a mistake. What's wrong with this?" This revealed that the novice user tended to get lost and became nervous after an error occurred. However, the expert showed confidence in controlling and regulating their searching process no matter what happened in the process.

Finally, the expert was familiar with how to use search engines and data base query systems; however, the novice showed some problems with them. This implied that knowing how to use helpful searching tools on the WWW is an important issue for successful searching. Besides, the novice showed little try-and-error strategies when problems occurred; however, the expert used this strategy a lot when a bottle net occurred. This indicated that try-and-error was an important problem solving skill for a successful searching in the WWW.

5 Discussions

Based on the results of this study, the differences of strategies utilized by the Internet novice user and the expert user can be summarized as following six aspects: computer self-efficacy, task anxiety, search aids, information processing, concentration, and problem solving. Computer self-efficacy [11] means how users perceived their abilities toward utilizing computer technology. The expert user tended to have higher computer self-efficacy than the novice user. This strategy relates to users' prior computer experience and believes about learning computers. Changing the novice users' views or believes about their computer abilities might be a solution to enhance their searching effectiveness and efficiency.

Task anxiety refers to worrying about not being able to reach the goal of a searching task. This strategy relates to environmental expectation and support. Group searching task with peer support might be a solution to help the novice search information on the WWW. Search aids indicates to users' knowledge and abilities to use tools that help search on the WWW, e.g. search engines and data base query systems. This relates to users' prior-knowledge and experience of using a data retrieval system. Providing a metaphor of such a system and practicing the query skills could enhance the novice users' abilities in this aspect.

Information processing refers to the ability to read in information from computer screen, select main ideas, evaluate, transfer, and integrate the information, and finally make decisions for the next destination. Strategies like looking through headlines and hyperlinks immediately after visiting a web page could help novice users to encode web information. Except encoding, many other strategies belong to this aspect. They include differentiating, monitoring, formulating, integrating, extracting, angling, collecting, controlling, decision-making, and reflecting [5]. In addition, this study shows evidence to support Hill's [5] conceptual framework of seeking information in an open-ended information system. Because the novice did repeat the behaviors of the navigational stage [5], but seldom performed the actions belonged to the process stage [5]; however, the expert in this study did perform the actions of both stages and show how to control and manage his searching process.

Concentration means the ability to keep attention on the searching task. The novice was easy to be interrupted by unrelated program messages or outside interferes. Have the mouse pointing to text which is currently being processed or read the text loudly might help the novice concentration on searching task. Problem solving means the ability to use try-and-error strategy when problems occur during searching. This strategy relates to users' creativity and problem solving styles. This strategy may be enhanced by successful practice experience.

6 Conclusions

The Internet novice users and expert users utilize different strategies to seek information in the WWW, an open-ended information system. Although the system design and users' system knowledge and domain knowledge may influence users' searching efficacy, users' metacognitive searching strategies may be enhanced through teaching and practice. By comparing the novice's and the expert's strategies used for seeking desired information through the WWW, this study identified six different aspects: computer self-efficacy, task anxiety, search aids, information processing, concentration, and problem solving. Future research should further investigate each aspect and examine the effects of the training of these strategies on users' searching efficacy.

References

[1] Borgman, C. L., "Why are online catalogs hard to use? Lessons learned from information-retrieval studies", Journal of the American Society for Information Science, Vol. 37, No. 6, pp. 387-400, (1986).

[2] Dias, P., Gomes, M. J., & Correia, A. P., "Disorientation in hypermedia environments: mechanisms to support navigation", Journal of Educational Computing Research, Vol. 20, No. 2, pp. 93-117, (1999).

[3] Ericsson, K. A., & Simon, H. A., "Protocol analysis: Verbal reports as data", Cambridge, MA: MIT Press, (1984).

[4] Hess, B., "Graduate student cognition during information retrieval using the World Wide Web: a pilot study", Computers & Education, Vol. 33, pp. 1-13, (1999).

[5] Hill, B., "A conceptual framework for understanding information seeking in open-ended information systems", Educational Technology Research & Development (ETR&D), Vol. 47, No. 1, pp. 5-27, (1999).

[6] Hill, J. R., & Hannafin, M. J., "Cognitive strategies and learning from the World Wide Web", Educational Technology Research & Development (ETR&D), Vol. 45, No. 4, pp. 37-64, (1997).

[7] Kashihara, A., Uji' I, H., & Toyota, J., "Reflection support for learning in hyperspace", Educational Technology, September-October, pp. 19-22, (1999).

[8] King, A., "Guiding knowledge construction in the classroom: Effects of teaching children how to question and how to explain", American Educational Research Journal, Vol. 31, No. 2, pp. 338-368, (1994).

[9] Lin, X., Hmelo, C., Kinzer, C. K., & Secules, T. J., "Designing technology to support reflection", Educational Technology Research & Development (ETR&D), Vol. 47, No. 3, pp. 43-62, (1999).

[10] MacGregor, S. K., "Hypermedia navigation profiles: cognitive characteristics and information processing strategies", Journal of Educational Computing Research, Vol. 20, No. 2, pp. 189-206, (1999).

[11] Oliver, T. A., & Shapiro, F., "Self-efficacy and computers", Journal of Computer-Based Instruction, Vol. 20, No. 3, pp. 81-85, (1993).

[12] Pressley, M., & Wolshyn, V., "Cognitive strategy instruction that really improve children's academic performance", Cambridge, MA: Brookline Books, (1995).

[13] Rosenshine, B., Meister, C., and Chapman, S., "Teaching students to generate questions: A review of the interaction studies", Review of Educational Research, Vol. 66, pp. 181-221, (1996).

[14] Titmus, C. J., "Lifelong education for adults: An international handbook", Elmsford, NY: Pergamon Press, (1989).

[15] Weinstein, C. E., & Hume, L. M., "Study strategies for lifelong learning", Washington, DCL American Psychological Association, (1998).

[16] Weinstein, C. E., & Mayer, R. E., "The teaching of learning strategies", Handbook of research on teaching, NY: MacMillan, 3rd Ed., pp.315-327, (1986).

Student Learning Issues: factors to consider prior to designing computer-assisted learning for higher education.

Paul Wilson* **and George Coghill****
**Christchurch Polytechnic, PO Box 22-095, Christchurch, New Zealand*
Email: wilsonp@cpit.ac.nz
***The University of Auckland, Private Bag, Auckland, New Zealand*
Email: g.coghill@auckland.ac.nz

Significant research has shown that most computer assisted learning systems in higher education are failing to meet the expectations of the developers, and students learning needs. The use of computer assisted learning systems is still not commonplace and there are factors negating increased usage. This paper reviews a number of human development and learning theories that should be considered before design of any learning experience. The major focus is on the behavioural and cognitive approaches that are believed to have the most importance when considering the design of computer assisted learning systems. Current research in student learning in higher education is included as is an outline of individual variations in learning experiences. It is concluded that an awareness of the behavioural learning processes and cognitive theories when designing CAL systems in the various categories could provide enhanced learning opportunities for the students using the systems. The application and use of appropriate learning strategies to improve student learning outcomes is in accord with current research in traditional teaching areas

Keywords: **learning theories, higher education, computer assisted learning system design**

1 Introduction

A study of 104 projects using information technology (IT) in developing course material for use in higher education found that many students learned less from IT programs than from face-to-face teacher contact; "fewer than a third of programs offered through information technology improve student learning"[2]. The report went on to say, "that while many of the projects did benefit students and academics, inadequate staff development and students' unsophisticated understanding of learning meant IT was not always being put to maximum use". While this study is confined to IT projects in Australian universities it is thought likely that similar dire results would be obtained in most other countries and learning environments.

Despite more than two decades of research and development in the area of computer assisted learning (CAL), the usage of these systems is still not common place in any more than a few isolated areas; "few have survived the realities of large-scale implementation in typical classrooms and those that have report significant implementation problems"[7]. Two of the major contributing factors negating the wide spread acceptance and use of computer technology are the high resource cost, for both hardware procurement and courseware development, and the low level of enabling teacher development to allow them to use this new resource to its maximum potential.

CAL is the most popular term in Europe while Computer Aided Instruction (CAI) is more often used in North America and Asia. The use of the word instruction has a special significance. It usually means that the package is not only conceived and designed by a teacher but that the effective control remains with him/her at every stage. The content and its delivery, including the degree of elaboration, the rate of flow of information and the order of presentation are decided by the teacher only. Being teacher-centred, the design is expository rather than explanatory in nature.

In contrast, CAL is designed to have student-centred activities. The student decides how much she/he needs to learn, in what sequence, to what depth and at what rate. The learning process is usually exploratory. Theoretically, the need to take care of individual differences amongst students is much higher in designing a CAL package than in a CAI package.

Significant scope remains for research and development of CAL in the higher education context, just as it does in the junior and senior school environments. "We need to understand better the relationship between technology, pedagogy, project oriented curricula, and student learning" [9]. It is believed that one of the more crucial areas required for success in development of any teaching / learning package, be it traditional or computer assisted, is an understanding of student learning issues in the higher education context.

In this paper the major human development theories are briefly outlined with respect to research in student learning. This work allows student learning theories and approaches to be discussed in more detail, especially with respect to student learning in the higher education environment. Some of the more important variations that may impact on the overall outcomes of the students' learning are then outlined. The final contribution of the paper is to integrate relevant issues from the various student learning theories and recent research with respect to systematic design of CAL systems.

2 Human Development

The major theorist in this area is the Swiss psychologist Jean Piaget who formalised a theory of cognitive development based on four discrete stages. These four stages, with approximate relevant ages are (adapted from Woolfolk [13]);

1. Sensorimotor, from 0 to 2 years of age.
   Involving the senses and motor activity. Concepts of object permanence and goal-directed actions.
2. Pre-operational, from 2 to 7 years of age
   The stage before a child masters logical mental operations. Develops language and ability to use symbols to represent actions or objects mentally.
3. Concrete Operational, from 7 to 11 years of age
   Able to solve 'hands-on problems' in logical fashion. Able to classify, arranges objects in sequential order, and understands concepts of conservation and reversibility.
4. Formal Operational, from 11 to 15 years of age.
   Able to solve mental tasks involving abstract thinking and co-ordination of a number of variables.

Most psychologists agree that there is a level of thinking more sophisticated than concrete operations, but the question of how universal formal-operational thinking actually is, even among adults, is a matter of debate. According to some, the first three stages of Piaget's theory are forced on most people by physical realities [8]. Formal operations are not, however, so closely tied to the physical environment.

It is essential to realise that although a student might be participating in a higher education experience, that it is not necessarily congruent that they are able to think hypothetically about every problem that is presented to them. In many cases the students may be in a higher education environment only because of their ability to memorise formulas or lists of steps. "These systems may be helpful for passing tests, but real understanding will take place only if students are able to go beyond the superficial use of memorisation – only if, in other words, if they learn to use formal-operational thinking"[13].

Before continuing, it is worth noting that there have been a number of adaptations and alternatives proposed by psychologists to Piaget's theory of cognitive development in children. Most of these have come about in relatively recent research work that is well documented in Woolfolk[13]. One major alternative viewpoint is that culture shapes cognitive development in a child by determining what and how the child will learn about the world. The major spokesperson for this view is that of the Russian psychologist Lev Vygotsky who died more than 50 years ago. Recent translations of his work show that he provided an alternative to many of Piaget's ideas [13]. The concept of culture shaping learning styles is also supported in more recent studies [12].

3 Learning Theories

There are two main approaches to the study of learning: the behavioural and cognitive perspectives.

3.1 Behavioural Approach

The behavioural approach to learning assumes that the outcome of learning is a change in behaviour and emphasises the effects of external events on the individual. All behavioural learning theories are thus explanations of learning that focus on external events as the cause of change in observable behaviours. The four major behavioural learning processes are: contiguity, classical conditioning, operant conditioning, and observational learning.

3.1.1 Contiguity

This principle was the foundation for research in learning in the early parts of the twentieth century. The principle of contiguity states that whenever two sensations occur simultaneously and repeatedly, they will be become associated. If at some time later only one of the sensations occurs (a stimulus), the other will be recalled (a response). Learning by association, or the repetitive pairing of a stimulus and correct response, can be found in many educational contexts – consider for example spelling drills and multiplication tables.

3.1.2 Classical Conditioning

An extension of the contiguity principle is found in the theories of classical conditioning discovered by Ivan Pavlov in the 1920's. Classical conditioning allows for the association of automatic responses with new stimuli. Pavlov determined that in the first instance an unconditioned stimulus produces an unconditioned response. After conditioning (or 'learning'?) a previously neutral stimulus becomes a conditioned stimulus that can produce a conditioned response to the same extent that occurred with the unconditioned stimulus and unconditioned response pair. Pavlov's work also identified that conditioned responses are subject to the processes of generalisation, discrimination, and extinction. In many cases the emotional reactions to various learning situations are themselves learned in part through classical conditioning. We must acknowledge that emotions and attitudes are learned as well as facts and ideas in any learning environment.

3.1.3 Operant Conditioning

Contiguity and classical conditioning both focus on involuntary or automatic actions in response to stimuli. These involuntary actions are also referred to as respondents. It is obvious that not all human learning is automatic and that in many cases people actively operate on their environment to reach particular goals or cause certain effects. These deliberate, goal directed actions are called operants and the learning process involved in changing operant behaviour is called operant conditioning.

In operant conditioning people learn through the effects of their deliberate responses to their environment and as such is most applicable to classroom type learning environments. For an individual, the effects of consequences following their action may serve as reinforcement or punishment. Positive and negative reinforcement will strengthen the response while punishment may decrease or suppress the response. The scheduling of reinforcement can influence the rate and persistence of responses. Ratio schedules encourage higher rates of responses while variable schedules encourage persistence of responses [13].

3.1.4 Observational Learning

Social cognitive learning theorists emphasise the role of observation in learning and in non-observable cognitive processes. There are two main modes associated with observational learning. First, learning through observation can occur through vicarious conditioning. This is when a student sees others being rewarded or punished for various behaviours and so modifies their behaviours as if they had received the consequences themselves. Second, the observer imitates the behaviour or actions of a model even though the model receives no immediate reinforcement or punishment while the observer is watching. This mode is when the model is demonstrating something that the observer wants to learn and expects to be rewarded for mastering. There are four major elements associated with observational learning; paying attention, retaining information or impressions, producing behaviours, and being motivated to repeat the learned behaviours [13].

3.2 Cognitive Approach

The cognitive approach to learning emphasises how students perceive, remember, and understand information. Cognitive psychologists focus on changes in knowledge and believe that learning is an internal mental activity that cannot be observed directly. There is no single combining theory and thus the cognitive view of learning can best be described as a generally agreed-upon philosophical orientation [13].

Under the cognitive approach, knowledge is categorised into different types (after [13] and [5]):

- General knowledge is information that is useful in many kinds of tasks or that may be applied to many different situations.
- Domain-specific knowledge is information that is useful in only a particular situation or that applies to only one specific topic.
- Declarative knowledge is *knowing that* something is the case, facts, beliefs, theorems, opinions, names, rules, poems, and the like. This type of knowledge has a tremendous range and may be organised into small units or larger units, which themselves may consist of several well-organised smaller units.
- Procedural knowledge is knowledge that is demonstrated when performing a task, that is *knowing how*.
- Conditional knowledge is *knowing when and why* to apply declarative or procedural knowledge.

The most influential and thoroughly studied model of cognitive research is the information processing model that provides an explanation of the cognitive processes involved in learning. It has grown from the work of a number of theorists (e.g. [3] and [6]).

3.2.1 Information Processing

In the information processing model the learning is approached primarily through a study of memory. A schematic representation of a typical information processing model of learning is shown in Figure 1(after [[13] and [5]).

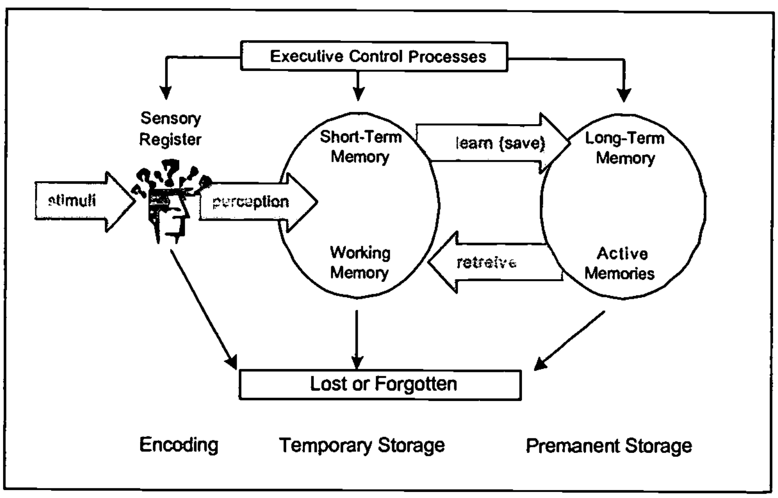


Figure 1 – The Information Processing Model

The three stages of the information processing system are the sensory register, short term memory and long term memory. The sensory register encodes some or all of the information received from the senses. Some of the information is not registered at all, some is ignored and some is simply forgotten. Perception determines what will be held in short term memory for further use.

The working memory only has a limited capacity so the information must be processed immediately or it will be forgotten. For information to be retained for longer than a few seconds it must be actively learned and stored in the long-term memory. Retrieval is the process of locating and recalling information to short-term memory.

The executive control processes guide and direct the processes involved in transferring information from the external environment to the long-term memory. These processes include directing attention, selecting strategies, and monitoring progress towards goals and motives.

Learning in the information processing model involves the construction of information in the memory, rather than the direct transfer of information from external environment to long-term memory. Learners use learning or cognitive strategies to actively acquire and manipulate information from the environment and their memory.

3.2.2 Metacognition

Metacognition literally means knowledge about cognition and has two aspects. The first aspect refers to an awareness of, and knowledge about, cognition. It includes the *declarative* and *procedural* knowledge of the skills, strategies, and resources needed to perform a task effectively, and the *conditional* knowledge needed to ensure successful completion of the task [13].

The second, and more important aspect, relates to the control and regulation of cognition, as this is the aspect that controls and regulates the use of strategies that are known by the learner. The control and regulation aspect includes three general processes: planning, monitoring and self-evaluation. Planning helps learners decide which strategies to use and how to process information effectively. Monitoring helps learners understand the information and integrate it with their existing knowledge. Self-evaluation helps learners check and correct their learning behaviour as they work through a learning task.

3.3 Constructivist

The constructivist approach to learning emphasises that people construct knowledge for themselves as a result of their interactions with their environment. Through this construction process, individuals build their own understandings and ways of looking at the world and the information sources in it. This does not mean that each person constructs knowledge in their own way that may be totally different from others. In most cases knowledge and understanding are constructed in an agreed and shared social context.

The constructivist approach subsumes a variety of theories, including information processing and social cognitive theories. The principal theorists in this area are Gagne [6], and Brown et al. [4].

Constructivist views of learning are important because they inform teachers of where to direct their effort in order to promote effective learning. The important features include the basic cognitive processes, strategies to guide these processes, knowledge about those strategies and one's own thinking processes, knowledge about the world in general, motivational beliefs, goals and overall cognitive style.

The immediate implications for learning are that students must be active learners and must be able to use a variety of learning strategies that will help them learn with understanding [5].

4 Variations

Learning is a complex multivariable phenomenon with respect to both process and outcomes [10]. Each student will be subject to intrinsic and extrinsic factors and driving forces that will impact on their learning. These factors and driving forces must be acknowledged and, if possible, allowed for in both traditional and computer assisted teaching environments. The first three of the factors outlined below are referred to as the 'big three' of student learning behaviours and essentially explain contrasting individual forms of engagement with the content and context of learning. The remaining factors can be used to construct more complex multivariable models for individual approaches to learning.

4.1 Intention

All students have some objective in mind when they start a course of study in higher education, the *what* question. Each student's individual response to this question may reflect a variety of contrasting intentions, or even a multiple intention. The most basic distinction is between the internal transformation of information into knowledge (construction of personal meaning), and the accumulation and reproduction of information (storage and recall). Other strategic intentions may be focused on the outcomes of higher education.

4.2 Motivation

Closely coupled with intention is the motivation for learning, the *why* question. Students are motivated by a wide range of feelings that traverse the entire spectrum of human experience. Abraham Maslow has had a great impact on the psychology of motivation and his hierarchy of needs model sets the foundation for research into human motivation. Other aspects to be considered in student motivation are arousal, goals, attribution, and beliefs [13].

4.3 Process

A materialistically motivated strategic intention to achieve high marks, for example, will not guarantee that high marks will be achieved. At even the most basic level in higher education some type of organised cognitive process or learning method will be required, the *how* question. Process is not simply a mental consideration in learning activity; it is at least partially influenced by the underlying intention and motivation.

4.4 Context

A students learning behaviour will be shaped by perceived circumstances or situational demands. Correctly identifying and applying the cues embedded in the context of learning (especially those related to task demands) are an important part of what might be called 'skill in learning' [10]. Perceptions that students form about the context of learning are closely associated at the individual process level with other sources of variation.

4.5 Regulation & Locus of Control

It has been demonstrated that various forms of regulatory mechanisms, such as those that clarify and direct learning activities, can help explain individual learning variations [11]. Individuals also vary to the degree to which they perceive causal attribution for academic success to be within, or beyond, their control [10]. Studies have determined the importance of locus of control as a determinant of learning outcomes in higher education.

4.6 Student Conceptions

Students differ considerably in their conceptions of what learning is. In broad terms the conceptual distinction lies between accumulative, the quantitative collection of knowledge for possible future use, and transformative, the use of knowledge to internally rearrange and construct new knowledge for developing personal meaning. These contrasting conceptions of learning are associated with differing forms of learning behaviour [10].

4.7 Cultural Factors

Recent research in the area of cultural impact on student learning has demonstrated that there is danger in assuming a culture-free interpretation of basic learning processes [10]. Indeed, culturally embedded values and practices must also shape any student learning behaviour model.

4.8 Gender

"The issue of gender related differences in learning behaviour does create some controversy" [10]. However, recent work in this area has shown that basic sources of variation used in student learning model construction may be defined differently in terms of gender specific responses – which, as a logical consequence, raises the possibility of gender specific models of student learning.

4.9 Discipline Specificity

The possible causes of variations outlined to this point have one thing in common; they are all general in nature and should be considered for any learning situation. As most learning in a higher education setting is essentially content focused there is an obvious need to address variations that may be specific to a particular discipline. These variations may be either a function of the content itself (for example higher level mathematics) or the broader context in which they are embedded and is perceived to be a part of (for example higher mathematical concepts in an electrical engineering course).

5 Student Learning Issues of Importance in the Systematic Design of Computer Assisted Learning Systems

Other researchers in the field of CAL have recognised the relevance of considering issues from cognitive psychology in the design of CAL systems. The areas of cognitive theory concerning perception and attention, memory, comprehension, active learning, motivation, locus of control, transfer of learning, and individual differences have previously been identified as being most important to CAL design [1].

However, it is believed that the consideration of cognitive theory to the exclusion of other learning issues can only lead to an incomplete analysis of the wider learning issues affecting all students in a higher education environment. Of even more concern is the concept of a CAL system being designed with no consideration given to any of the student learning issues. This could be a partial explanation for the poor results reported in the survey of Alexander & McKenzie [2].

Issues considered to be of importance in the systematic design of CAL are as follows:

5.1 Use of Formal-Operational Thinking

There are few instances in CAL in higher education where students are not required to proceed beyond the superficial use of memorisation. Therefore it is vital that a CAL system design ensure that the students are required to use formal-operational thinking to achieve the learning required.

5.2 Cultural Aspects

With the increasing globalisation of education there are many instances in a higher education environment where there may be several cultures in any particular group of students. The design of a CAL system must not allow one cultural group to be advantaged, or disadvantaged, at the expense of others due to the predominance of a particular learning style or cultural influence in the system.

5.3 Behavioural Influences

CAL systems may include learning experiences ranging from simple drills to complex simulations. An awareness of the behavioural learning processes when designing CAL systems in the various categories could provide enhanced learning opportunities for the students using the systems. Of most benefit are the operant conditioning and observational learning processes. Research from operant conditioning shows that the scheduling of reinforcement, or CAL system feedback in this particular instance, must be designed to ensure that the aim of the system is achieved – that is, higher rates of responses or persistence of responses. Research from observed learning shows that mastery can be achieved through observation – how this observation can be achieved in a CAL system needs careful consideration during the design process.

5.4 Cognitive Influences

The work of Alessi & Trollip [1] has gone some way towards setting a base for the use of cognitive theory in designing CAL systems. Recent research has increased the awareness, and importance, of metacognition in student learning. The control and regulation of the cognition aspect of metacognition shows the importance of considering this aspect when designing CAL systems. The application and use of appropriate learning strategies to improve student learning outcomes is in accord with current research [5]. Just because a student is 'learning' from a computer does not mean that they would not benefit more from an increased awareness of learning styles and strategies.

5.5 Constructivist Approaches

The constructivist approach to student learning also has a great deal to offer designers of CAL systems. In this approach, students must positively interact with their environment – they must become 'active learners'.

One of the most enabling features of properly designed CAL is its ability for interaction with the student. However, too much of one thing can soon become tiring and thus eventually negatively motivating, therefore this is one area that needs more research to ensure the much heralded benefits of CAL systems eventuate.

5.6 Individual Variations

Meyer [10] notes that learning is a complex multivariable phenomenon with respect to both process and outcomes. Alessi & Trollip [1] also note that the often praised and supposed advantage of CAL to individualise is, just like interactivity, not often taken advantage of. All of the outlined individual variations must be at least considered when designing a CAL system. The big three of intention, motivation and process should always be factored into CAL system design. Context, regulation and locus of control, and discipline specificity may provide significant opportunities for the CAL system designer to truly individualise the system for the learners.

6 Conclusions

Many of the learning issues outlined in this paper are only now starting to be recognised as important aspects for students in higher education [5], [10]. With an increasing reliance on computer and information technology in higher education it is now imperative that the opportunity is taken to consider learning issues as a first step in the systematic design of computer assisted learning systems.

This paper has outlined some of the more important human development, learning theories, and learning approaches considered relevant to the systematic design of CAL systems. Significant research effort is being undertaken in applying these theories and approaches to 'traditional', or face-to-face, teaching in higher education. As any CAL system is no more than an extension of the existing traditional methods it is imperative that similar research work is conducted in the CAL design area.

Work remains to be carried out in developing a systematic approach to integrating teaching concepts, in addition to that completed in this paper on learning issues, in the design of CAL systems.

It is concluded that only once a complete understanding of those learning and teaching issues in higher education are mastered, will a comprehensive and systematic design approach for CAL systems be able to be developed.

References

[1] Alessi, S.M. & Trollip, S.R.,. "Computer based instruction: methods and development", Englewood Cliffs: Prentice Hall, (1985).

[2] Alexander, S. & McKenzie, J., "An evaluation of information technology projects for university learning", Canberra: Australian Government Printing Service. (1999).

[3] Atkinson, R.C. & Shiffrin, R.M., "Human memory: A proposed system and its control processes", in K Spence & J Spence (Eds.), "The psychology of learning and motivation", Vol. 2, New York: Academic Press, (1968).

[4] Brown, A.L., Bransford, J.D., Ferrara, R.A., & Campione, J.C. "Learning, remembering and understanding", in P.H. Mussen (Ed), "Handbook of child psychology", Vol. 3 (4th Edn, pp.77-166), New York: John Wiley & Sons, (1983).

[5] Chalmers, D. & Fuller, R., "Teaching for learning at university", London: Kogan Page, (1996).

[6] Gagne, R.M., "The conditions of learning", 4th Editiion, New York: Holt, Rinehart and Winston, (1985).

[7] Ladewskii, B.G., Krajcik, J.S., & Harvey, C.L., "A middle grade science teacher's emerging understanding of project based instruction". Elementary School Journal, Vol. 94, pp. 499-515, (1994).

[8] Neimark, E., "Intellectual development during adolescence", in F.D. Horowitz (Ed.), "Review of Child Development Research", Chicago: University of Chicago Press, (1975).

[9] Mergendoller, J.R., "Moving from technological possibility to richer student learning: revitalised infrastructure and reconstructed pedagogy", Educational Researcher, Vol.25, No. 8, pp. 43-46, (1996).

[10] Meyer, J.H.F., "A medley of individual differences" in B. Dart & G. Boulton-Lewis (Eds.), "Teaching & learning in higher education", Melbourne: Australian Council for Education Research Ltd., (1998).

[11] Vermunt, J.D.H.M, & Van Rijswijk, F.A.W.M., "Analysis and development of students' skill in self regulated learning". Higher Education, Vol. 17, pp. 647-682, (1988).

[12] Watkins, D. "Assessing approaches to learning: A cross-cultural perspective" in B. Dart & G. Boulton-Lewis (Eds.), "Teaching & learning in higher education", Melbourne: Australian Council for Education Research Ltd., (1998).

[13] Woolfolk, A., "Educational psychology", 5th Edition, Needham Heights, Ma: Allyn & Bacon, (1993).

Students' Attitude toward WPSS in Supporting Classroom Learning

Hsiu-Ping Yueh
Department of Agricultural Extension, National Taiwan University,
#1, Sec. 4, Roosevelt Rd, Taipei 106, Taiwan
Tel: 886-2-23630231-2750
FAX: 886-2-23647221
Email: yueh@ccms.ntu.edu.tw

While the web-based learning environment has become more flexible and has more functions than traditional instructional media as well as many computer-assisted instruction, the EPSS has also become an expanding area within the field of education. This paper first describes the features of and rationale behind electronic performance support system as well as web-based performance support system; demonstrates the implementation of the web-based performance support system in assisting students' learning in a real-time multicast distance classroom; discusses the research methodology; explores the effectiveness of the use of the web-based performance support system in supporting students' learning; and provides conclusions and implications for the filed of education.

Key Words: **Distance Education, Electronic Performance Support System (EPSS), Web-based Performance Support System (WPSS)**

1 Introduction

Electronic Performance Support System (EPSS) was originally defined as a system that provides just-in-time information, advice, learning experiences, and tools in the form of electronic to help people perform a task with the minimum support from other people [3]. Based on the early definition, EPSS was perceived by many people as an interactive computer-based environment which attempts to facilitate or improve human performance such as problem solving abilities within some target application domain. To help organizations design and develop EPSS with a broader systems thinking approach, Raybould (1995) proposes that an EPSS is "the electronic infrastructure that captures, stores and distributes individual and corporate knowledge assets throughout an organization, to enable an individual to achieve a required level of performance in the fastest possible time and with the minimum of support from other people"(p.66)[6].

A number of existing technologies have been selected and integrated into design and development of an EPSS, such as artificial intelligence (AI), hypermedia, computer-based training (CBT), intelligent tutors and microworlds [5]. With the impact of the growth and development of network technology, internet or intranet has become one of the most important delivery vehicle for the EPSS. A Web-based Performance Support System (WPSS) is an innovative approach by utilizing the technologies of the world-wide-web (WWW). For a WPSS, the web is not only a delivery medium, it also provides contents and serves as subject matter experts (SMEs) as well. The DISTED (Distributed Information System & Training for Educators at a Distance Education) as an example of a WPSS has successfully functioned as a system which helps educators design, delivery and evaluate teaching in the interactive distance education [7]. The WPSS has been proved to be a better design than the traditional EPSS in terms of it's features such as cost-effectiveness, open architecture, universal acceptance and pervasive delivery [2].

Many training experts contended that Electronic Performance Support Systems are the learning tools of the 21st century [4]. While most of the major developments and applications of EPSS were designed for industrial and commercial settings, more and more educators in many academic organizations have begun to adopt the concept and implement EPSSs in their classes. As the educational environment becomes more dynamic, the possibility of adequately imparting necessary knowledge to learners within a limited instructional schedule is increasingly challenging. Considering that our knowledge base is expanding rapidly and information is being updated at the speed of telecommunications, some educators therefore started to employ an integrated use of EPSS to facilitate learners' information retrieval. For example, Schwen, Goodrum, & Dorsey (1993) used the EPSS to create an enriched learning and information environment [8]; Law (1994) employed the metaphor of "cognitive training wheels" to describe EPSS as it facilitates learners' acquisition of skilled performance.

According to the early definition of EPSS, there are usually four major components embedded in a performance support system which includes information, training, advice and tools. To improve the functions and the design and development of a better performance support system, many researchers proposed different models of putting together an EPSS with necessary components. Gery (1991) listed three levels of functionality with four components at each level, they are user interface, help, coach/advisor, and tutor [3]. McGraw (1995) suggested that the components of an EPSS should include the human-computer interface, the help system, the coaching/advisor system, and the tutor component [5]. Baker and Banerji (1995) proposed an approach to design and implement of EPSS facilities based upon the use of a multi-layered model containing four basic levels including human-computer interface, generic tools, application specific support tools, and application domain [1]. In general, an EPSS should have four typical components including tools, information base, advisor, and learning experiences [9] to be able to support performance.

While we are moving into the resource-based learning environment in the field of education, the way of teaching and instruction has been changed accordingly. Teachers are no longer experts but facilitators or guilders; textbooks is also instead by a variety of learning resources and media. Internet is a very good tool in terms of providing the resource-based learning environment. The world-wide web with hypertext markup language (HTML) provides an easier way to present large volumes of text electronically, using efficient client/server architecture to transfer different kinds of data, such as texts with fancy fonts, colorful graphics, even sound and video clips in packets across the internet. As an integrated tool, WWW allows users to share and transfer data files easily, as well as communicate and interact more effectively. Also as a self-directed learning tool, a WPSS provides a rich environment with up-to-date information, real-world learning experiences, as well as worldwide learning resources, with which students can self-pace, monitor, and evaluate their learning.

2 Method

The purpose of this study were to investigate the effectiveness of the WPSS in supporting students' learning as well as to understand students' attitude toward this system. The target population for this study is a class of students (82 students totally) registering in the distance education course titled "Web-based Instruction and Training" in Spring 1999. A WIT Web Site was designed and developed as a web-based performance support system to assist students' learning of this course. At the end of the semester, a copy of questionnaire was also designed and distributed to students to collect their perception toward this Web Site. Moreover, students' answers to a posttest essay of the final exam were reviewed for the purpose of evaluation. The data collected were analyzed by means of Descriptive Statistics, correlation, and regression study.

3 Results

For the attitude survey, most students showed positive attitude toward content information (usefulness, richness, helpfulness), format design (screen design, visual images design, layout consistency, links arrangement), and composition (organization, presentation, delivery, references) of this WIT Web Site. Besides, students' comments also showed that most students thought this Web Site is a useful tool in general especially it meets different learning needs of students. Furthermore, the results showed that there is a moderate correlation between students' attitude with their final exam scores. And findings suggest that most students are willing to use this kind of supporting system in their learning if other courses could provide in the future.

4 Conclusions

1. Evidence from students' attitude survey and feedback comments shows that the web based performance support system is a powerful tool in terms of assisting learning especially in the distance education learning environment. It serves as a self-directed learning tool with which students can self-pace, monitor, and evaluate their learning, which may in turn facilitate students in developing life-long learning skills.

2. Results of this study also shows that the WIT Web Site provides a powerful communication channel between instructor and students, as well as students at different learning sites in the distance education course. More specifically, the web-based discussion boards were claimed by students to be a very useful tool to expand the interaction and communication outside classroom.

3. Most Electronic Performance support Systems were used in the industrial settings in the past, however, results of this study has approved that a WPSS can also be an excellent tool for providing just-in-time assistance in the learning environment of formal education. Students perceived it as a good learning tool in many aspects including the application to future study in other contexts or subject areas. This experience of facilitating students learning on the internet can be applied in other curriculum at different levels of schools.

Reference

[1] Baker, P., & Banerji, A., "Designing electronic performance support systems, Innovations in Education and Training International, 32(1), 4-12. (1995)

[2] Chang, C. C. (1999). Designing, developing and evaluating an electronic performance support system for performing and learning instructional designing tasks. In G. Cumming et al. (Eds.), Advanced Research in Computers and Communications in Education (Vol. 2, pp. 423-426). Ohmsha: IOS Press.

[3] Gery, G., "Electronic performance support systems: How and why to remake the workplace through the strategic application of technology". Tolland, Mass: Gery Performance Press. (1991).

[4] Hoyt, B.R., Stockman, M., & Thalmann, J., "Design and implement custom electronic performance support systems (EPSS) for training in project based classes. ASCUE Proceedings, 100-107. (ED document 410925) (1997)

[5] McGraw, K.L., "Selecting appropriate functionality and technologies for EPSS, Innovations in Education and Training International, 32(1), 13-22. (1995).

[6] Raybould, B., "Making a case for EPSS, Innovations in Education and Training International, 32(1), 65-69. (1995)

[7] Remmers, E. (1998). Guidelines for WWW-based support environments for education professionals. URL: http://mw75.student.utwente.nl/~elka/litstudy/

[8] Schwen, T. M., Goodrum, D.A., & Dorsey, L. T., "On the design of an enriched learning and information environment (ELIE). Educational Technology, 33(11), 5-9. (1993)

[9] Yueh, H., Liu, F., & Wang, P., "Assessing the effectiveness of a web-based EPSS. Paper presentated at the Annual Conference of the Association for Educational Eommunication and Technology, St. Louis, MO. (February, 1998).

Students' Attitude toward WPSS in Supporting Classroom Learning

Hsiu-Ping Yueh
Department of Agricultural Extension, National Taiwan University,
#1, Sec. 4, Roosevelt Rd, Taipei 106, Taiwan
Tel: 886-2-23630231-2750
FAX: 886-2-23647221
Email: yueh@ccms.ntu.edu.tw

While the web-based learning environment has become more flexible and has more functions than traditional instructional media as well as many computer-assisted instruction, the EPSS has also become an expanding area within the field of education. This paper first describes the features of and rationale behind electronic performance support system as well as web-based performance support system; demonstrates the implementation of the web-based performance support system in assisting students' learning in a real-time multicast distance classroom; discusses the research methodology; explores the effectiveness of the use of the web-based performance support system in supporting students' learning; and provides conclusions and implications for the filed of education.

Key Words: **Distance Education, Electronic Performance Support System (EPSS), Web-based Performance Support System (WPSS)**

1 Introduction

Electronic Performance Support System (EPSS) was originally defined as a system that provides just-in-time information, advice, learning experiences, and tools in the form of electronic to help people perform a task with the minimum support from other people [3]. Based on the early definition, EPSS was perceived by many people as an interactive computer-based environment which attempts to facilitate or improve human performance such as problem solving abilities within some target application domain. To help organizations design and develop EPSS with a broader systems thinking approach, Raybould (1995) proposes that an EPSS is "the electronic infrastructure that captures, stores and distributes individual and corporate knowledge assets throughout an organization, to enable an individual to achieve a required level of performance in the fastest possible time and with the minimum of support from other people"(p.66)[6].

A number of existing technologies have been selected and integrated into design and development of an EPSS, such as artificial intelligence (AI), hypermedia, computer-based training (CBT), intelligent tutors and microworlds [5]. With the impact of the growth and development of network technology, internet or intranet has become one of the most important delivery vehicle for the EPSS. A Web-based Performance Support System (WPSS) is an innovative approach by utilizing the technologies of the world-wide-web (WWW). For a WPSS, the web is not only a delivery medium, it also provides contents and serves as subject matter experts (SMEs) as well. The DISTED (Distributed Information System & Training for Educators at a Distance Education) as an example of a WPSS has successfully functioned as a system which helps educators design, delivery and evaluate teaching in the interactive distance education [7]. The WPSS has been proved to be a better design than the traditional EPSS in terms of it's features such as cost-effectiveness, open architecture, universal acceptance and pervasive delivery [2].

Many training experts contended that Electronic Performance Support Systems are the learning tools of the 21st century [4]. While most of the major developments and applications of EPSS were designed for industrial and commercial settings, more and more educators in many academic organizations have begun to adopt the concept and implement EPSSs in their classes. As the educational environment becomes more dynamic, the possibility of adequately imparting necessary knowledge to learners within a limited instructional schedule is increasingly challenging. Considering that our knowledge base is expanding rapidly and information is being updated at the speed of telecommunications, some educators therefore started to employ an integrated use of EPSS to facilitate learners' information retrieval. For example, Schwen, Goodrum, & Dorsey (1993) used the EPSS to create an enriched learning and information environment [8]; Law (1994) employed the metaphor of "cognitive training wheels" to describe EPSS as it facilitates learners' acquisition of skilled performance.

According to the early definition of EPSS, there are usually four major components embedded in a performance support system which includes information, training, advice and tools. To improve the functions and the design and development of a better performance support system, many researchers proposed different models of putting together an EPSS with necessary components. Gery (1991) listed three levels of functionality with four components at each level, they are user interface, help, coach/advisor, and tutor [3]. McGraw (1995) suggested that the components of an EPSS should include the human-computer interface, the help system, the coaching/advisor system, and the tutor component [5]. Baker and Banerji (1995) proposed an approach to design and implement of EPSS facilities based upon the use of a multi-layered model containing four basic levels including human-computer interface, generic tools, application specific support tools, and application domain [1]. In general, an EPSS should have four typical components including tools, information base, advisor, and learning experiences [9] to be able to support performance.

While we are moving into the resource-based learning environment in the field of education, the way of teaching and instruction has been changed accordingly. Teachers are no longer experts but facilitators or guilders; textbooks is also instead by a variety of learning resources and media. Internet is a very good tool in terms of providing the resource-based learning environment. The world-wide web with hypertext markup language (HTML) provides an easier way to present large volumes of text electronically, using efficient client/server architecture to transfer different kinds of data, such as texts with fancy fonts, colorful graphics, even sound and video clips in packets across the internet. As an integrated tool, WWW allows users to share and transfer data files easily, as well as communicate and interact more effectively. Also as a self-directed learning tool, a WPSS provides a rich environment with up-to-date information, real-world learning experiences, as well as worldwide learning resources, with which students can self-pace, monitor, and evaluate their learning.

2 Method

The purpose of this study were to investigate the effectiveness of the WPSS in supporting students' learning as well as to understand students' attitude toward this system. The target population for this study is a class of students (82 students totally) registering in the distance education course titled "Web-based Instruction and Training" in Spring 1999. A WIT Web Site was designed and developed as a web-based performance support system to assist students' learning of this course. At the end of the semester, a copy of questionnaire was also designed and distributed to students to collect their perception toward this Web Site. Moreover, students' answers to a posttest essay of the final exam were reviewed for the purpose of evaluation. The data collected were analyzed by means of Descriptive Statistics, correlation, and regression study.

3 Results

For the attitude survey, most students showed positive attitude toward content information (usefulness, richness, helpfulness), format design (screen design, visual images design, layout consistency, links arrangement), and composition (organization, presentation, delivery, references) of this WIT Web Site. Besides, students' comments also showed that most students thought this Web Site is a useful tool in general especially it meets different learning needs of students. Furthermore, the results showed that there is a moderate correlation between students' attitude with their final exam scores. And findings suggest that most students are willing to use this kind of supporting system in their learning if other courses could provide in the future.

4 Conclusions

1. Evidence from students' attitude survey and feedback comments shows that the web based performance support system is a powerful tool in terms of assisting learning especially in the distance education learning environment. It serves as a self-directed learning tool with which students can self-pace, monitor, and evaluate their learning, which may in turn facilitate students in developing life-long learning skills.

2. Results of this study also shows that the WIT Web Site provides a powerful communication channel between instructor and students, as well as students at different learning sites in the distance education course. More specifically, the web-based discussion boards were claimed by students to be a very useful tool to expand the interaction and communication outside classroom.

3. Most Electronic Performance support Systems were used in the industrial settings in the past, however, results of this study has approved that a WPSS can also be an excellent tool for providing just-in-time assistance in the learning environment of formal education. Students perceived it as a good learning tool in many aspects including the application to future study in other contexts or subject areas. This experience of facilitating students learning on the internet can be applied in other curriculum at different levels of schools.

Reference

[1] Baker, P., & Banerji, A., "Designing electronic performance support systems, Innovations in Education and Training International, 32(1), 4-12. (1995)

[2] Chang, C. C. (1999). Designing, developing and evaluating an electronic performance support system for performing and learning instructional designing tasks. In G. Cumming et al. (Eds.), Advanced Research in Computers and Communications in Education (Vol. 2, pp. 423-426). Ohmsha: IOS Press.

[3] Gery, G., "Electronic performance support systems: How and why to remake the workplace through the strategic application of technology". Tolland, Mass: Gery Performance Press. (1991).

[4] Hoyt, B.R., Stockman, M., & Thalmann, J., "Design and implement custom electronic performance support systems (EPSS) for training in project based classes. ASCUE Proceedings, 100-107. (ED document 410925) (1997)

[5] McGraw, K.L., "Selecting appropriate functionality and technologies for EPSS, Innovations in Education and Training International, 32(1), 13-22. (1995).

[6] Raybould, B., "Making a case for EPSS, Innovations in Education and Training International, 32(1), 65-69. (1995)

[7] Remmers, E. (1998). Guidelines for WWW-based support environments for education professionals. URL: http://mw75.student.utwente.nl/~elka/litstudy/

[8] Schwen, T. M., Goodrum, D.A., & Dorsey, L. T., "On the design of an enriched learning and information environment (ELIE). Educational Technology, 33(11), 5-9. (1993)

[9] Yueh, H., Liu, F., & Wang, P., "Assessing the effectiveness of a web-based EPSS. Paper presentated at the Annual Conference of the Association for Educational Eommunication and Technology, St. Louis, MO. (February, 1998).

Students' thinking processes when learning with computer-assisted mass lectures.

Nopphol Pausawasdi* and Dr Lyn Henderson**
School of Education, James Cook University,
Townsville, Queensland 4811, Australia
Phone: 617 4781 6984
Facsimile: 617 4725 1690
*Email: *Nopphol.Pausawasdi@jcu.edu.au,*
***Lynette.Henderson@jcu.edu.au*

This paper presents findings from a research project that examined students' thinking during mass lectures that utilized interactive multimedia (IMM). The data were obtained from six second year Thai medical students via stimulated-recall interviews. The reported thinking (or mediating) processes engaged in by the students during the mass lectures that related to the academic content of the physiology subject are detailed and discussed. We identified 18 different types of thinking skills including generating, anticipating/predicting, linking, metacognition, analyzing, and categorizing. These ranged from a high usage frequency (generating) to a low usage frequency (categorizing). Being able to understand such student thinking may result in more effective use of IMM in mass lectures. The data are also compared with studies that provided students' reported thinking processes when studying with the WWW, IMM, and text-based material. The significant differences in the mediating processes between using IMM in computer-assisted mass lectures, where the students did not directly interact with the IMM, and hands-on use of IMM, the WWW, and text-based material are discussed.

Keywords: **Thinking skills, Computer-assisted mass lecture, IMM, medical education, Thai medical students**

1 Introduction

There is increasing use of IMM in mass lectures in universities for teaching and learning. Yet IMM supported lectures do not guarantee better content learning or higher-order thinking than do traditional instruction methods. There is much research and literature concerning instructional design, the characteristics of IMM, and learning: for instance, the use of educational technology [1] and the effects of colors [2], animations [3], and interactivity [4]. Research has neglected how students engaged with the new technology in lectures. The research by Nowaczyk, Santos, and Patton [5] examined student perceptions of various characteristics of multimedia such as color transparencies, video, and PowerPoint in tutorials and mass lectures. However, they did not investigate students' thinking processes about the academic content. The research by Faraday and Sutcliffe [6] examined visual attention and comprehension of multimedia presentations. Research by Putt, Henderson, and Patching [7] and Henderson, Putt, Ainge, and Coombs [8] examined learners' mediating process about the academic content of IMM and WWW courseware, respectively. However, these did not focus on an IMM mass lecture context.

Studies report that IMM can be effective in encouraging higher order thinking skills when learners work with IMM individually or, better still, in pairs or small groups [9, 10, 11]. However, in a mass lecture, the IMM is controlled by the lecturer. Learners play a passive-receiver role. Are they focused on the content? What sort of thinking about the content do they engage in?

Heeding current literature in the field [1, 12, 13], the study does not aim to ascertain whether learningwith

IMM supported lectures produces better learning or test outcomes than traditional lectures. Rather, it utilizes qualitative methodologies to ascertain the students' thinking skills as they learned in the authentic context of a lecture theatre. Thus the study sought to:

(a) identify and categorize the thoughts concerning the content of the IMM supported lectures that were reported by the students;

(b) compare the mediating processes reported in the computer-assisted mass lecture study with those reported in research which identified the reported mediating processes that occurred in three studies where students had hands-on use of IMM software, WWW courseware, and text-based materials respectively; and

(c) with respect to (b), evaluate our hypothesis that the type of interaction with the learning materials would be a significant factor, that is, the lack of direct manipulation of the learning materials would result in lower percentage frequencies of reported mediating processes (our study) compared with those reported in the other studies that had direct hands-on interaction.

2 Methodology

Much existing research data regarding the efficacy of computer mediated environments is anchored in the process-product paradigm. The paradigm is based on the assumption that instructional stimuli give rise to learning outcomes. Recognition of the simplistic nature of this general cause-effect paradigm when applied in education, led to the adoption of the mediating process paradigm that focuses on student thought processes that mediate, or come between, instructional stimuli (the IMM supported lecture) and learning outcomes [14]. Mediating processes can be viewed as the fine-grained elements of cognition through which, and by which, learning outcomes are realized. Thus, learning outcomes are the function of the mediating processes activated by instructional tasks and other learning activities. Salomon [11] describes the contrast between analytic research that is focused on isolating effective instructional treatments and systemic research focused on understanding how instructional treatments work in practice. This study embraced systemic research focussing on the sorts of thinking that tertiary students engaged in during IMM supported lectures.

It is a qualitative study utilising stimulated recall interviews to ascertain students' thinking in authentic contexts. Learning is related to the quality and quantity of thinking undertaken by learners [15]. To categorize and tabulate students thinking skills, a process-tracing methodology is utilized. It involves appropriate self-reporting techniques through using a video to stimulate recall of cognitive processes engaged in during a learning/study session. The stimulated recall interview technique follows strict guidelines [14]. Triggered by such things as the students' non-verbal actions or what is appearing on the computer screen, non-leading questions are asked, such as: "You seemed to frown; can you tell me what you were thinking?" and, in order to confirm that the reported thought occurred during the learning session and not while being interviewed, "Did you think that then or just now?" Both the interviewer and students can stop the video when they believe something is significant and, for the student, when the video triggers a thought that he/she had had during the initial study session. This method has been used in different settings with different mediums and with individuals, pairs, and small groups [7, 8, 16, 17, 18].

2.1 Context, Participants and Data collection

The research context and methodology capitalize on authenticity [11]. The students' thinking processes were obtained in realistic, ecologically-valid situations as the data were collected from students working in their regular environment. Thus for the current study, the research was conducted with a physiology class in a mass lecture theatre, Faculty of Medicine Siriraj hospital, Mahidol University, Bangkok, Thailand. The lecturer used A.D.A.M., The interactive physiology-muscular system [19] in the one hour lectures. Two lecture sessions were video recorded. Six students volunteered to participate in the stimulated-recall interviews. There were four males and two females with ages ranging from 17 to 19 years. They were in the third semester of a six year Medical degree. The six participants self selected into 3 pairs, 2 male pairs and 1 female pair. Working in pairs was the favored study practice of these Thai medical students. The first male pair was interviewed after the first lecture session; the others after the second lecture session. The content of both lectures was the same topic and used the same IMM. All six participants attended both lectures.

The interviews were conducted with one pair at a time. The interviewer and each pair of participants together viewed a videotape of the lecture and a synchronized computer screen showing the A.D.A.M. IMM software that was used in the lecture. The video picture included the lecturer's verbal and non-verbal behaviors and the content of the computer-assisted lecture. The computer screen showed the A.D.A.M. IMM software content which appeared on the videotape. Both videotape and computer screen facilitated the participant's recall and verbalization of their thinking during the lecture. The three stimulated recall interviews, one hour duration for each interview, were conducted immediately after the lecture sessions and were audio taped for later transcription and analysis.

3 Results

From the interview transcripts of the students' stimulated recall interviews, their thinking skills were identified, categorized, and then analyzed. Both authors together identified the thoughts from the first transcript. The others, they did individually. Then the data from each researcher were compared and discussed. Consensus was achieved when disagreement occurred. The data that were considered invalid, such as student's thinking that did not occur during the study session, the reports of students' activities that were not related to their thinking, and answers where the interviewer had led the student, were identified and discarded. Only students' thinking that occurred during the study session were identified as useable data.

The students' thinking data reported by participants were classified according to the mediating processes identified by Henderson, et al. [8]. The 18 mediating processes identified in our study are listed in Table 1 which provides a definition for each thinking skill and a clarifying example of each from the data.

Type	Description Mental activity in which a student -	Example
Affect	reports feelings aroused by content during study	"He [the lecturer] clicked A. I was glad. My answer was correct."
Analyzing	Reduce, breaks down whole (e.g., problem, task) into parts	"I've learned that content. There were some new parts adding to it. The rest was old."
Anticipation	predicts or states expectations that problem, question, or textual feature will be encountered; wonders about: the possibility of an event, relevance of material, content	" He [the lecturer] was talking about timing. So, I thought ahead that it must higher. And when stimulated, a bit slower - it would be lower."
Applying	Considers the use of an idea, tactic in a different context.	"When I saw the clearer image, I thought they should use this technique in the textbook because it can't use animation."
Categorization	Sorts items, ideas, skills into different groups	"I thought I already noted this as asynchronous."
Comparison	identifies similarities, differences between two statements, concepts, models, situations, ideas, theories, points-of-view, etc.	"From the graph shown on screen, I thought it would appear in another way."
Confirmation	judges that ideas in text support one's own beliefs, practices, tactics	"When he [the lecturer] clicked, I just thought that one is correct."
Deduction	reasoning process by which a specific conclusion necessarily follows from a set of general premises	"I felt the image doesn't look real because the vesicle [4small bags within a larger bag] has just 4 bags and the water filled this space."
Deliberation	engages in "thinking" about a topic, prose segment, etc. (type of thinking not disclosed)	"I was thinking about the question."
Diagnosis	identifies strengths and weaknesses in idea, strategies, points-of-view	"I thought it made me understand better by cropping and enlarging the picture. So I can see it clearly"
Evaluation	makes judgments about the value, worthwhileness of textual materials, activities, in-text questions, own position or point-of-view	"I thought the topic shown at the top was good. It told me what I was going to learn."
Generating	formulates one's own questions, examples, ideas, or problems; interpolating; going beyond the data	"What does the handle look like? Stimulate by hands! Do we use hands to do that?"
Imaging	creates a mental image of an idea in text in order to gain a fuller understanding	"I thought about the real muscle and how it should look if I cut it"
Linking	associates or brings together two or more ideas, topics, experiences, tasks	"I thought about the frog's leg in the laboratory."
Metacognition	thinks about, reflects on, evaluates or directs own thinking	"I couldn't see the shrink in the first animation. I thought I need to focus more on the next one"
Recall	brings back into working memory an idea, opinion, fact stored in long-term memory	"This picture, I thought I learned it before."
Reflection	general indication of careful consideration or thought over past action and response; tries to establish the reason or causal link between the action and its response	"When this graph was shown, I thought the latent period is narrow. At first, I thought it would be wide and red like the previous one."

Strategy Planning	plans ways of processing or handling content material during study or learning sessions	"When I saw these, I would open the textbook. I did not wait. I would note the additional information in the textbook."

Table 1: Mediating Processes Identified in the Present Study

Note: Descriptions are adapted from Marland, et al. [14] and Henderson, et al. [8]; examples are from the current study.

The frequencies for each type of mediating process were tallied (Table 2). The data in Table 2 indicate the frequency of the 18 identified mediating processes. The data shows the different frequency of mediating processes between three pairs and the variation in the frequency of occurrence of mediating processes. These ranged from

Categories of classification	*Mediating Process (i.e., thinking skills)*	*Frequency (1st male pair)*	*Frequency (female pair)*	*Frequency (2nd male pair)*	*Total*	*Percentage (%)*
Content	Generating	3	19	11	33	14.5
	Anticipating/Predicting	1	10	20	31	13.7
	Linking	2	14	11	27	11.9
	Metacognition	11	7	6	24	10.6
	Evaluating	6	7	7	20	8.8
	Strategy Planning	0	6	10	16	7.0
	Recalling	8	3	4	15	6.6
	Affective	3	2	9	14	6.2
	Confirming	0	4	5	9	3.9
	Deliberating	1	2	6	9	3.9
	Diagnosing	6	1	2	9	3.9
	Imaging	0	0	7	7	3.0
	Reflecting	1	6	0	7	3.0
	Comparing	0	3	1	4	1.4
	Applying	1	1	0	2	0.9
	Deducing	1	0	1	2	0.9
	Analyzing	1	0	0	1	0.4
	Categorizing	0	0	1	1	0.4
	Total thoughts	45	85	97	227	100
	Mean number of mediating processes per pair from 3 pairs		76		based on responses	

Table 2: Frequency of Mediating Processes Related to Academic Content.

14.5% for "generation" to 0.4% for "analyzing" and "categorizing". A total of 227 mediating processes were identified from the transcripts. The mean number of reported mediating processes per pair was 76. The first male pair who were interviewed after the first lecture reported 45 mediating processes. The other male and the female pair who were interviewed after the second lecture reported 97 and 85 mediating processes, respectively. Familiarity with content and presentation probably influenced the higher number of thinking processes during the second lecture.

Mediating processes	*This study:* IMM in mass lectures (%)	*Study by Henderson, et al.. (1997):* IMM study (%)	WWW study (%)	Text-base study (%)
Generating	very high (14.5)	high (8.4)	very high (10.1)	Low (3.6)
Anticipating/Predict.	very high (13.7)	high (7.8)	very low (1.4)	high (5.9)
Linking	very high (11.9)	very high (11.4)	very high (11.5)	very high (10.4)
Metacognition	very high (10.6)	very high (19.8)	high (9.4)	very high (12.4)
Evaluating	high (8.8)	very high (18.0)	very high (26.5)	very high (18.6)
Strategy Planning	high (7.0)	very low (1.8)	high (7.7)	very high (16.8)
Recalling	high (6.6)	high (6.6)	very low (1.0)	low (4.1)
Affective	high (6.2)	very high (14.4)	high (9.4)	high (7.8)
Confirming	low (3.9)	Very low (1.8)	low (4.5)	very low (2.8)
Deliberating	low (3.9)	very low (1.8)	very low (2.8)	none (0.0)

Diagnosing	low	(3.9)	none	(0.0)	low	(3.1)	low	(0.26)
Imaging	low	(3.0)	very low	(0.6)	very low	(2.4)	none	(0.0)
Reflecting	low	(3.0)	none	(0.0)	very low	(0.003)	none	(0.0)
Comparing	very low	(1.4)	low	(4.8)	very low	(2.1)	very low	(1.5)
Applying	very low	(0.9)	none	(0.0)	none	(0.0)	none	(0.0)
Deducing	very low	(0.9)	none	(0.0)	very low	(1.4)	none	(0.0)
Analyzing	very low	(0.4)	very low	(2.9)	none	(0.0)	very low	(1.1)
Categorizing	very low	(0.4)	none	(0.0)	very low	(1.0)	very low	(0.005)

Table 3:Comparative students' mediating processes frequency between this study and the study by Henderson, et al. [8]

The data in Table 3 show the variation in the frequency of occurrence of mediating processes in our study and that by Henderson, et al. [8] which reports data from three different studies. In these three studies, the tertiary education students had hands-on control of the IMM software, the WWW courseware, and the text-based materials. (Our research was not aimed at arguing that one type of learning material [the IMM in mass lectures, the hands-on IMM study, the WWW study, or the text-based study] was better educationally. Our intention with the comparison frequency of thinking processes was that, if the quality and quantity of reported thinking skills was comparable with those reported in the other three studies, and if hands-on interactivity did not appear to be a crucial factor, then lecturers would feel a level of confidence in using IMM in mass lecture.)

Based on four level divisions used in the Marland, et al. [14], Putt, et al. [7], and Henderson, et al. [8] studies, the frequency of occurrence is divided into very high, high, low, and very low in order. In all studies, the 3% and 10% cut-off figures were arbitrarily chosen, whereas 5.5% (100/18), the cut-off for the "high" category, was the average percentage frequency across all 18 categories.

In Table 3, the categories of generating, anticipating/predicting, linking, and metacognition have the highest frequency (f>10) in this study. According to the study by Henderson, et al. [8], linking was rated very high in learning with the WWW, IMM, and text-based materials as well. However, while anticipating/predicting rated as very high in this study, it rated as low in the WWW study and high in the IMM and text-based studies. Evaluating was reported often in all four studies. It was rated as high in this study and very high in the other three studies. Interestingly, strategy planning was very low (f<3) in the IMM study, but it rated as high in this study and the WWW study and very high in the text-based study. Recalling rated as high in only the two studies that used IMM. Comparison of the results show that ten mediating processes (confirming, deliberating, diagnosing, imaging, reflecting, comparing, applying, deducing, analyzing, and categorizing) occurred in the low to very low frequencies in all four studies.

4 Discussion

The following discussion focuses on the comparison of mediating processes that were reported by students during their learning sessions. In the computer-assisted mass lectures, the A.D.A.M. IMM software was used as a teaching-learning tool. It played a major role in the lectures. However, the students were not in a position that allowed interaction with the IMM. They were a group of passive-receivers who possibly consumed the content provided by the lecturer via the IMM features. Therefore, the data obtained in our study concerns the reported mediating processes of students who learned with IMM without direct hands-on interaction. The comparison data between our study and that reported by Henderson, et al. [8] reveals factors that influenced students' mediating processes while learning with different mediums. Moreover, it also revealed the differences in the quantity and quality of the reported thinking skills when students had direct hands-on interaction versus receiver interaction.

The top frequency percentages for the four studies are 26.5% (WWW), 19.8% (IMM), 18.6% (text-based), and 14.5% (our study). The data reveal a higher percentage frequency of the most reported thinking skills in the studies where students had hands-on interaction control. If we add the percentages of all mediating processes in the "very high" category for all four studies then the differences are 63.6% (IMM), 58.2% (text-based), 50.7% (our study), and 48.1% (WWW). Nevertheless, even though the students in the hands-on WWW study had the fewest reported mediating processes in the very high frequency range, there was only a small percentage difference (2.6%) between it and our study. In terms of these criteria, the data generally tends to support our hypothesis. The students in the hands-on IMM study obviously reported more mediating processes than those in the IMM computer-assisted mass lectures. However, when the number of mediating processes per person in all four studies is averaged, the results are 38 per person for our study, 16 per person for the IMM study, 36 per person for the WWW study, and 28 per person for the text-based study. The low hands-on IMM number was affected by having learner groups of more than two students; beside two groups of two students there was one of three and one of four students in the stimulated recall interviews [20]. Nevertheless the highest number was in our study where students did not have hands-on control. Moreover students in our study reported more types (18) of mediating processes during learning. Students in the WWW, IMM, and text-based studies reported 16, 14, and 13 different types of mediating processes respectively. The students in the WWW study did not report applying and analyzing. The students in the IMM study did not report reflecting, applying, deducing, and categorizing. Those in the text-based study did not report deliberating, imaging, reflecting, applying, and deducing (Table 3). Breadth, that is, the number and type of different mediating processes are relevant to engaging meaningfully with the content as is the number per individual. Thus hands-on control does not seem to be the crucial factor here. The following discussion examines these issues concerning our hypothesis by singling out various mediating processes for analysis and reveals that our hypothesis is tenuous.

The top four mediating processes in our study were generating, anticipating/predicting, linking, and metacognition in descending order. "Generating" encompasses one or more of the following: (a) formulation of one's own questions, examples, ideas, opinions, problems, and answers; (b) interpolation by adding new knowledge through the elaboration of existing knowledge within a given framework; and/or (c) extrapolation which adds new knowledge by extending an existing framework and going beyond the data. The reason for the very high percentage for generating is because of the cause-effect relationship between their thoughts and the animation features of A.D.A.M., which led the students to focus on the content [21]. Generating has a very high frequency (14.5 %) in our study, a high frequency (8.4%) in the IMM study, a very high frequency (10.1%) in the WWW study, and a low frequency (3.6%) in the text-based study. Therefore, direct hands-on interaction might have caused the lower frequencies of generating in the hands-on study. Students in the three studies reported by Henderson, et al. [8] might have engaged in the jobs they needed to do to control the IMM and the WWW materials and underline or take verbatim notes from the text materials. Thus resulting in less focus on the content. Students in the computer-assisted mass lectures just followed the lecturer's presentation, which may have allowed them to allocate more time to focus on the content.

"Anticipating/predicting" includes predicting, looking forward to, speculating about, and expecting the likelihood of encountering problems, types of content, and features of the medium. Anticipating/Predicting is the second highest ranked mediating process having a very high frequency in our study. It had a high frequency in the other IMM study. A possible explanation for this finding is that the lecturer was the only person who controlled the A.D.A.M. IMM software, thus the students anticipated and predicted what the lecturer decided to present and what would emerge in the A.D.A.M. presentation. Students in the IMM study had direct interactive hands-on control of the IMM. Therefore, it is possible that they automatically clicked the mouse to move to the next page, clicked for the answer to embedded questions, and clicked to control the animation without allowing time for anticipation or prediction. The very low score (1.4%) for the WWW study appears to be an anomaly. Perhaps the content, particularly the instructional design of the content, did not promote these thinking skills. Or perhaps the students used the hypermedia functions of the WWW and engaged in thoughts such as "I will click on this link" rather than wondered what content ideas would be presented embedded in that link. In our study, students in the computer-assisted lectures had to wait for lecturer interaction. Thus, during waiting, they had more time to anticipate or predict the coming content.

"Linking" had a very high frequency in all four studies. It is defined as the process of associating, or bringing together in the mind, two or more ideas, topics, contexts, personal experiences, words, and so forth. From this finding, linking occurred easily when text, picture, graphic, or animation that illustrated the concept prompted recall of an associated item in the student's memory. Therefore, it is not surprising that linking occurred very often in all studies because they contain those elements that influenced students to consider how the information related to their experiences. This also shows that, in comparison with our study, direct hands-on interaction did not influence the linking processes.

Mediating processes classified as "metacognition" are those in which students reported awareness of, reflecting on, evaluating, or directing their own thinking. This definition reflects a widely accepted view of metacognition as referring to students' knowledge about, and control over, their cognitive processes. The findings show that metacognition had the fourth highest frequency of mediating processes in this study. The students were able to engage with the content and thinking about their own thinking as it related to the content, and were less inclined to be sidetracked by the features of IMM, the lecturer, and student-idiosyncratic factors [21]. Metacognition had very high and high frequencies in the four studies (see Table 3). In three studies the percentage frequencies were similar: our study (10.6%), the WWW study (9.4%), and the text-based study (12.4%). However, there was a significant gap between these and that for the hands-on IMM study (19.8%). A factor that possibly made the gap is that the hands-on IMM study contained embedded questions that forced students to interact in order to receive feedback and to be able to move to the next section. In our study, the A.D.A.M. software also offers the same feature, but the students did not have hands-on control. The text-based study also provided embedded questions, but did not provide feedback and also did not "force " the students to answer those questions. The WWW study did not provide embedded questions. This comparison shows that the different pedagogical instructional design in conjunction with the hands-on control is a crucial factor that influenced metacognition. Nevertheless, it is still significant that students engaged in metacognition, which is a type of thinking that is considered to be one of the highest types of cognitive processes [22].

"Evaluating" is defined as the mental process in which a judgement is made about the value or worth of some aspect of the content of the instructional material. Evaluating had a high frequency (8.8%) in this study. The percentage of reported evaluative thoughts about content is very high in the other three studies (18.0%, 26.5%, and 18.6%). The gap between our study and the other three studies is significant. The students in the other three studies used the learning tools by themselves. Thus, it would seem that hands-on experiences and, hence, control over their own pacing and navigated sequencing with the learning tools produced more evaluative thoughts. In computer-assisted lectures, the students may not have had enough time to evaluate the content as well as generate new ideas, link to their past experiences, or metacognise. Perhaps, the students in our study rationalized that if the lecturer had purposely selected out this particular IMM A.D.A.M. material then it was important. In the hands-on studies, the students had to make the evaluative decision as to what content was worthwhile or relevant to their individual goals.

"Strategy planning" refers to thought processes in which students plan ways of processing or handling instructional material or activities during study or learning sessions. There is a dramatic gap between the frequency percentage for IMM study (1.8%) and the other three: our study (7.0%), the WWW study (7.7%), the text-based study (16.8%). The students in our computer-assisted mass lecture study had to follow the lecturer's presentation. One could therefore assume that the frequency rate would be "very low"; but why then the very low score for the IMM study? There appear to be three explanatory factors. The first factor suggests, as is the case with lectures in general, in our study students planned how to deal with the information and process the content through note-taking, drawing graphs, and deciding whether to annotate the textbook or attempt to draw or describe the animations that they cannot control. The second factor is that the students in the IMM study when interacting with IMM, did not appear to spend time thinking about how they would process the material but instead just followed the linear sequence programmed as the "default" choice [8]. The third factor is that, in comparison with the IMM study, in which assessment was not a factor, the students in the computer-assisted mass lectures, the text-based, and the WWW studies knew that the content was assessable. This might have influenced the students' strategy planning.

"Recalling" is defined as bringing back into working memory ideas, opinions, and facts previously stored in long-term memory. It has a high frequency (6.6%) in both studies that used IMM while it was rated very low (1.0%) in the WWW and low (4.1%) in the text-based studies. The gap between the studies that used IMM and those that did not use IMM is substantial. It is possible that the features of the IMM products, such as animation and enforced embedded questions, encouraged students to recall their previous knowledge and experiences during learning.

It is interesting that confirming, deliberating, diagnosing, imaging, reflecting, comparing, applying, deducing, analyzing, and categorizing were rated as low or very low (see Table 3) in all four studies. The type of interaction (hands-on or receiver), the mediums and their features did not seem to influence these types of mediating processes. This implies that factors that should be considered are the content and whether its instructional design prompted these types of thinking skills.

5 Conclusion

It has been argued that IMM is more useful as a learning tool when used individually or with others rather than in mass lectures where students could be seen as merely passive receivers. Our study shows that hands-on interaction does not appear to be such a crucial variable. Indeed in our study, the quantity, quality and range in type of mediating processes were greater than, or comparable to, the other studies. Therefore, the authors argue that IMM can be used as a cognitive tool in mass lectures to enhance various thinking shills. This study draws the attention of instructional designers and lecturers to the existence, types, and relative frequencies of mediating processes in which students engage with while learning with computer-assisted mass lectures. They were not passive receivers but active receivers. Our study highlights the need for instructional designers to plan educational materials that will activate desired mediating processes as part of student learning in computer-assisted mass lectures.

References

[1] Glenna, T. K. & Melmed, A. (1996). Fostering the use of educational technology: Elements of a national strategy. A Rand Report. Santa Monica, CA: Rand. [Also Online] http://www.rand.org/publications/MR/MR682/contents.html Accessed 31 March 2000.

[2] Chapman, W. (1993). "Color Coding and the Interactivity of Multimedia," Journal of Educational Multimedia and Hypermedia, pp.3-23.

[3] Rieber, L. (1991). Theoretical foundations of instructional applying of computer-generated animated visuals," Journal of Computer-Based Instruction, 18(3), 83-88

[4] Sims, R. (1998) Interactivity for effective educational communication and engagement during technology based and online learning, [On line] http://wwwtlc1.murdoch.edu.au/gen/aset/confs/edtech98/pubs/articles/rs/sims1.html. Accessed 3 March 2000.

[5] Nowaczyk, R., Santos, L., & Patton, C. (1998). Student perception of multimedia in the undergrad classroom. International Journal of Instructional Media, 25(4), 367-382

[6] Faraday, P., & Sutcliffe, A. (1996). An Empirical study of Attending and Comprehending Multimedia Presentations. London: City University, pp 265-275.

[7] Putt, I., Henderson, L., & Patching, W. (1996). Teachers' thinking elicited from interactive multimedia professional development courseware. Educational Technology Research & Development, 44(4), 7-22.

[8] Henderson, L., Putt, I., Ainge, D., & Coombs, G. (1997). Comparison of student thinking process when studying with WWW, IMM, and Text-based material.

[9] Park, I., & Hannafin, M. (1993). Empirically-based guidelines for the design of interactive multimedia. Educational Technology Research & Development, 41(3), 63-85.

[10] Simpson, M. (1994). Neurophysiological consideration related to interactive multimedia. Educational Technology Research and Development, 42(1), 75-80.

[11] Salomon, G. (1998, February). Novel constructivist learning environments: Some issues to be concerned with. Paper presented at Thinking in Teaching and Learning Conference, Jerusalem.

[12] Clark, R. E. (1994). Media will never influence learning. Educational Technology Research and Development, 42(2), 21-29.

[13] Reeves, T. (1997). Pseudoscience in qualitative research. [Online] ITFORUM listserv. ITFORUM@UGA.CC.UGA.EDU Access date: 3 March 2000.

[14] Marland, P.W., Patching, W.G., & Putt, I. (1992). Learning from text: Glimpses inside the minds of distance learners, Townsville: James Cook University.

[15] Litchfield, B. C. (1992). Evaluating 0f inquiry-based science software and interactive multimedia programs. Computing Teacher, 19(6), 41-43.

[16] Galluzzo, G.R. (1984, April). A study of student-teacher thinking. Paper presented at Annual Meeting of American Educational Research Association, New Orleans

[17] Mostert, M.P. (1996). Contextualized thinking about teaching: Special educators' metaphorical representations of practical knowledge. In L. Bouton (Ed.), Pragmatics and language learning (pp. 189-213). Urbana-Champaign, Ill: University of Illinois.

[18] Norton, R.A. (1987 April). Divining and defining a problem space: An investigation of preservice teachers' interactive thinking. Paper presented at Annual Meeting of American Educational Research Association, Washington, DC.

[19] Branstrom, M. (1996). A.D.A.M. The interactive physiology-muscular system [CD-ROM], A.D.A.M. Software, Inc. and Benjamin & Cummings Publishing, Atlanta, GA

[20] Patching, B., Henderson, L., & Putt, I. (1994, February). Interactive and Thinking: A report on research in progress. Paper presented at Second International Symposium on Interactive Multimedia, Perth.

[21] Pausawasdi, N., & Henderson, L. (2000, June-July). Students' Engagement Behaviors in Computer-Assisted Mass Lectures. Paper presented at World Conference on Educational Multimedia, Hypermedia, and Telecommunication, Montreal.

[22] Osman, E. M., & Hannafin J. M. (1992). Metacognition Research and Theory: Analysis and Implications for Instructional Design. Educational Technology Research and Development, 40(2), 83-99.

Telementoring in Surgery

U Kyaw Tin Hla* and Soe Soe Nwe**
**Department of Surgery , Kulliyyah of Medicine, International Islamic University Malaysia IIUM, Jalan Hospital 25150,Kuantan, Pahang Darul Makmur, MALAYSIA, Tel:609-5132797 ext 3437 Fax: 609 -5133615 Email ukyaw@iiu.edu.my, kthla@hotmail.com, kthla@pd.jaring.my,*
***UNIMASClinic, Kota Samarahan, 94300,Sarawak, Malaysia, Email snsoe@mailhost.unimas.my*

1 Introduction

Mentoring or supervision in surgical operations is very labour–intensive. Hands-on learning is part of the method of teaching and learning in operative surgery. This requires one-to-one learning in the presence of an instructor or guru. This is expensive and time consuming yet necessary if the student is to learn effectively and their ability accurately assessed.

Telementoring in surgical operations in remote areas of Malaysia, as in inaccessible parts of the rest of the world, could become a reality by using existing hardware/ software solutions and facilities over the World Wide Web in a cost effective way. This is being developed and tested by the authors and a group of students.

The first stage of the project has shown that this new development in pedagogy can be used effectively and has the potential for many useful future applications. With further extensions it will be a useful new educational method for distance learning students and less-experienced colleagues. Expansion of this approach, the second stage of the project, will enable real-time supervision of the teaching -learning process of students of surgery. This will mean it will be as if the guru is beside the learner at all times; saying " stop" when the mentor wants the student/ learner to reconsider, (either when undertaking a procedural step or during the operation), and then giving instructions on how to carry out the correct operative steps at the very moment required. Such corrections will be under the supervision and direct vision of the guru who, despite his remote location from the operation, will have everything under his control .

The first stage of the project was undertaken in Sarawak, where many rural people, as in other parts of Borneo, have problems in accessing specialists in an emergency due to the rough terrain which makes immediate transfer of patients impossible. Although helicopters are employed they cannot operate after 6pm or in bad weather and they are costly. When the second stage of the project is completed, health authorities with such remote populations will have an affordable option to improve access to specialists for its citizens by providing mentoring to junior doctors.

Such technology could save lives in areas were speedy evacuation of patients is not an option. It is also a cost-effective way of training medics and other health care providers in remote areas.

2 Hypotheses and Rationales

Telementoring in surgical operations in remote areas of Malaysia, or the rest of the world, could be made a reality by making use of existing hardware/software and the facilities over the WWW in a cost effective way, at the same time as achieving acceptable resolutions for clinical use for decision making and supervision during surgical undertakings

3 Objectives of Project

The project consists of two stages each with its own set of objectives. These are:
Stage 1

a. To test if the best quality recordings of surgical operations, performed by the author during his weekly surgery in Sarawak General Hospital, were clinically acceptable after digitizing them for video streaming.

b. To determine if images could be transfered over the intranet, later the internet, using easily available existing hardware and software solutions.

c. To evaluate the acceptability of the output for clinical decision making with regards to clarity, resolution, speed and voice clarity and quality.

Stage2.

a. To develop real-time videostreaming of surgical undertakings by incorporating the output from stage one into an improved version of a web-based module previously developed by the author.

b. To test the outcome

4 Materials and Method (Stage 1) TELEMENTORING OVER THE INTRANET

Recordings were made using a Sony TRV 301E Digital camera on Sony Hi 8digital tape while surgery was carried out by the author. The video recordings were turned into digital clips of approximately 100 Megabytes AVI on a Sony VAIO Laptop Personal Computer, PCG-F360, using video-capturing software DVGate Motion from Sony. Firewire Link IEE 1394, three metre in length was used for fast transfer at 200MB/ second rate in real time. A laptop PC was used as it has the added advantage of being mobile and therefore could be used anywhere where there was a www connection. This would enable supervision of emergency surgery from a mobile unit.

The clips of approximately 100 Meg made on ***DV Gate Motion*** were first converted into raw AVI uncompressed using software **MainActor**. The resulting AVI produced were turned into a media file compatible with Microsoft Media Player using on **Demand Producer**, a Window 2000 Professional product. Media clips of similar size were then produced by using Real **Producer** which were subsequently played on Real Player G2.

Each of these clips were transferred over to another PC over the Local Area Network (LAN) and viewed using widow Media Player (Microsoft 2000 Professional Beta product) and Real Player G2 (freeware). The video quality was evaluated by the author and two other independent viewers for clarity, definition, resolution, speed and sound quality and whether it was acceptable for clinical decision making. The first testing was done over the local area network on UNIMAS' s campus.

5 Results

Findings -.The evaluations as shown in the table for the three available digital capture format and viewers , showed comparable results on all test- runs . Same video clips of operation on total thyroidectomy was used. for standard comparison.

Sony avi	RealG2	Media player	
+++	+++	+++	**Clarity**
+++	+++	++	**Definition/Resolution**
++	++	++	**Speed**
++	++	++	**Voice**

6 Conclusion

The project was found to be viable using just the available facilities. An acceptable resolution, clarity and definition was achieved for both clinical decision making and supervision during surgery.The three objectives of the first stage were met. This is an interim report of our encouraging results. This was a necessary pilot project to test the standard of the video produced before developing the desired application of real-time videostreaming and telementoring of surgical applications over the WWW. This second stage will use an improved version of a web-based module previously created by the author and presented at ICCE 99 held in Chiba, Japan. Production of this module used Pinnacle' s MP10 hardware software solution which, together with the use of a digital camera, helped to eliminate this intermediate and time consuming steps of initial conversion to raw AVI clips before it could be used on a Real server is used for streaming later .To be reported later. **TELEMENTORING IN SURGERY** using this innovative and value-added tool a junior medical officer in a distant district hospital, such as Kapit or Belaga in Sarawak, or Jeruntut in Pahang will definitely benefit from the instruction given in real-time by a senior surgeon in a specialist hospital using this innovative but inexpensive tool. *Telementoring is likely to become t*he very back-bone of **teleconsultation** , one of Malaysian Telemedicine Project, *as it will go beyond advice on clinical diagnosis and decision making to transferring surgical skills from the specialist to the novice.*

7 Bibliography

[1] Alaska Telehealth SystemAlaska Telemedicine Project.www.telemedicine.alaska.edu/, (1999).

[2] Davis Chapman,. Web Development With Visual Basic 5, 1st Edition.Que Corporation. (1997)

[3] Devzone RealNetwork, http://www.realnetworks.com/devzone/index.html(1999)

[4] GRiNS Editor Pro for RealSystem G2http://www.realnetworks.com/promos/bndl2.html (1999)

[5] Hla, Kyaw Tin, "New Paradigm of Facilitating Problem - Based Learning (PBL) over the World Wide Web in University Malaysia Sarawak", Advanced Research in Computers and Communications in Education, IOS Press, Amsterdam,/ Proceedings of 7th International Conference on Computers in Education (ICCE 99), Chiba, Japan,November 4-7,pp 819-820 (1999)

[6] Hla, Kyaw Tin," Problem - Based Learning over the Internet", Proceedings of 5th International Conference on
Computers in Education(ICCE 97), Kuching, Sarawak,Malaysia December 2-6,pp 1018-1020(1997)

[7] PinnacleSystemsInc,MP10http://www.pinnaclesys.com/frameset.asp?state=HomeVideoProduct&content =4 (1999)

[8] Pinnacle Systems Inc, MP10, http://www.pinnaclesys.com/frameset.asp?state=main (1999)

[9] Real Producer http://www.realnetworks.com/promo s/nprd2.htmlShelagh Galanger, Objectives and the Characteristics of Problem Based Learning (1997).

[10] Streaming Media StarterKit http://www.realnetworks.com/promos/starterkit/index.html?src=home (1999)

[11] Streaming Media Starter Kit,http://www.realnetworks.com/promos/bndl1.html (1999)

[12] Yale University of Medicine (1999). Telemedicine URL: http://info.med.yale.edu/yfp/about.html(1999)

The analysis of social discourse in a network-based learning community --The GeoSchool Experience

Fe-ching Chen *and Huo-Ming Jiang**
**Center for Teacher Education National Central University*
Chung-Li, Taiwan 320
E-mail: fcc@cc.ncu.edu.tw
***Institute of Atmospheric Science National Central University*
Chung-Li, Taiwan 320
E-mail: Jiang@front.atm.ncu.edu.tw

This paper is the first of a series of papers introducing the GeoSchool Project, a complex study to construct a network-based Earth Science learning environment for high school students. The set of papers will cover the following topics: (1) the theoretical foundations and research methodology; (2) data collecting and investigation software tools for visualization and quantitative analysis; (3) the project-based learning model; (4) issues raised by network-based learning experiences versus traditional classroom experiences; (5) the learning portfolio and social discourse; (6) the results and their implications. While in this paper we are focused on the analysis of social discourse and its implications in the GeoSchool experiences. 2685 articles were analyzed to discover the characteristics of the social discourse in the learning activity on the web. These articles were posted by 15 high school students and 10 mentors during a 15-day study on atmospheric science on the web. This is a study of the learners' authentic interactive process. The examination of the actual initiation and diminishing of threads in the social discourse reveals not only the characteristics of a network-based learning community mainly consisted of high schools, but also important scaffolding issues in the inquiry process. The paper looks into the following issues: What were the major categories of the 2685 posted articles? What kind of questions the learners asked? What kind of questions brought in replies and what didn't? What were the major categories of the mentors' articles? How could the mentor's scaffolding be helpful? What were the characteristics of the longer discussion threads? How could the learners scaffold each other? ... etc. After answering these questions we could then look into the broader aspects of a network-based learning community, namely, what influences did the network based learning environment have on the inquiry-based learning process of the high schools, what could we learn from the mentor-learner interactions, when did meaningful learning actually take place.

Keywords: **learning community, scaffold, mentor, Geoschool, social discourse posted articles**

1 Introduction

The thought that network-based learning environment facilitates learners to construct their own knowledge, to be reflective, and to be socially interactive has been fruitfully applied to science learning. The implication of inquiry learning in network-based learning environment also presents a number of significant challenges (Edelson, Gordin, & Pea, 1999). However, research on this field seldom showed a picture in detail of learners' interactions in such a technology-supported environment. Our goal has been to explore realistically what is the shared learning experience high school students might have and how do they articulate their own understanding, comment on each other's thoughts, and bear distributed expertise.

In this paper, we will describe and classify the articles posted on the network by both the learners and the mentors into categories in order to reveal the underlying learning styles, obstacles and scaffolding strategies. We discovered a number of characteristics of the learners' learning style and the social discourse in the network-based learning community.

2 THE PROJECT-BASED LEARNING MODEL

Over the past 3 years, the authors have been engaged in the development of cooperative project-based learning (PBL) environment of GeoSchool (http://geoschool.ncu.edu.tw). According to the definition of Krajcik (Krajcik, et al, 1998), the features of PBL learning include (a) a driving question; (b) investigations and artifact creation; (c) collaboration; (d) use of technological tools. The PBL in our GeoSchool is designed to facilitate five stages of inquiry and three steps of Co-op Jigsaw II (Kagan, 1992) teamwork. The five stages of inquiry are: problem definition, deciding variables to use and the procedures to take, data collection, data analysis and interpretation, drawing conclusions and presenting the findings. The three steps of teamwork are to form teams, to form expert groups to develop individual expertise, and then to go back to the team to share expertise. Figure 1 depicts this PBL learning model.

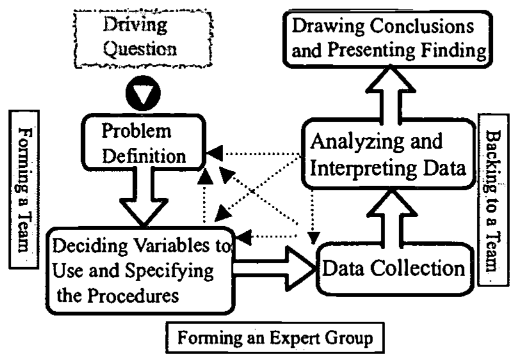


Figure 1. Cooperative PBL model

3 ROLE OF DISCOURSE IN SCIENCE LEARNING

The two major contemporary thoughts on science education are constructivism and the reflective practice. The constructivist approach involves heavy social discourse and interactions in its problematic, action taking, and reflective stages. Although reflection can be an individual activity, it can also be a social activity to be influenced by a community. Therefore the role of social discourse in science learning is gaining more importance than before. The social discourse can be helpful throughout the inquiry based learning process. For example, the learners could be inspired in the social discourse to revise and refine their original low-level factual problem definitions for higher-level abstraction; social discourse could also lead the learners to become aware of the inconsistency between their problem definitions and the conclusions they are trying to draw.

4 METHOD

4.1 Participants and Design

Participants were 15 high school students (10 girls and 5 boys), aged 16 to 17 years old, enrolled in 9 different senior high schools located in north, middle, and south part of Taiwan separately. In addition to the students, 10 university graduates and professors majored in atmospheric science also joined and served as mentors in the inquire process. Every three students formed a team by selecting one of the several driving questions they were interested in. No more than one member can come from schools in the same area so that they would be forced to communicate through the network-based learning environment. The assignment to the teams is to investigate and answer the assigned problem with justification. At the second step, each member of a team was assigned to one of the three different expert groups. A member should go on-line to his respective expert group to inquire knowledge and to bring back to his team to finish the assignment collectively as the third step. The students were given a database of primary knowledge source on CD containing background theories and factual data but not the plain answers to the assigned problems. They were also allowed to acquire knowledge outside of either resource.

The five assigned investigative problems were (1) while a cold front is passing through Taiwan, would it be colder in the north than in the south, (2) would a stationary front lingering on the east coast cause heavy rain falls, (3) what the influences of a storm cold front passing through Taiwan on the amount of rain falls in the north and in the south respectively, (4) would the amount of rain falls brought in by 'Spring-rain stationary front' be more than that brought in by 'Mei-yu stationary front', (5) after a cold front passed through, would the temperature in high mountains be lower than that on the level ground. While the three expert groups were scaffolding knowledge on (1) climatic factors, (2) weather map, (3) high altitude atmospheric exploration, respectively.

4.2 Procedure

The complete network-based learning program ran through a 2-week period. The learners in the study were instructed to follow the curriculum set for each team and the instructions were supplemented with on-line 'tour-guide'. Before the learning program took place, the students were gathered on one-day workshop on operational knowledge. They were tutored on concept map, PBL model, the usage of database of primary sources, the know how about getting on-line and to participate in the GeoSchool network-based learning environment. Returning home from the first day gathering, the learners did not meet face-to-face in the following 14 days except on the web in their respective team area in GeoSchool. The mentors worked with the learners every day on the web. After the conclusion of their problem assignment, all the participants did meet at the last day of the program to reflect and share their experiences through this network-based learning program.

4.3 Data collection and analysis

We used a portfolio of artifacts including assignments, concept maps, reports, and posted articles to create the study on how the learners engaged in the social discourse during the network-based learning period. Each learner's posted articles were recorded by the web-BBS/DNEWS system in the GeoSchool environment for analysis.

Data were analyzed in several phases. First, DNEWS record file was transformed into Excel format and the posted articles were displayed in table format. Then, the nature and contents of each article was analyzed and the columns of qualitative descriptors in the table were checked as the classification of this article. In addition to the categorization of the articles according to their nature and contents, the insight of the social discourse were also looked into in order to discover the characteristics of (1) the interaction between mentors and learners, as well as among learners, (2) the initiation and diminishing of the threads in the social discourse, particularly threads with questions included that sustained more than 5 thematic discussions (re-posts), and (3) the correlation between style and responses.

4.4 RESULTS

The results are presented here in five parts. They are the statistics of the classification of the articles posted by the learners and the mentors, the content properties of the social discourse and the questions raised in the posting, and the effectiveness of the scaffolding strategies applied by the mentors.

4.4.1 The Classification of the Articles Posted by the Learners and the Mentors

Table 1. Classification of Articles Posted by Learners

No.	Category	Frequency	Percentage
3	Social interaction	906	38.5
6	Content knowledge	628	26.7
7	Group progress & self-regulation	499	21.1
1	Network	123	5.2
4	Database of primary sources	103	4.4

2	PBL model	66	2.8
5	Methodology in science	31	1.3
Total		2356	100.0

Table 2. Classification of Articles posted by Mentors

No.	Category	Frequency	Percentage
6	Content knowledge	136	32.9
2	PBL model	64	15.5
3	Social interaction	55	13.3
1	Network	53	12.8
5	Methodology in science	48	11.6
7	Reinforcement	39	9.4
4	Database of primary sources	18	4.4
Total		413	100.0

The statistics of the attributes of the articles posted by the learners and the mentors are shown in table 1 and 2. The categories 1 to 6 in the classification are the same in both groups, while the 7th category is 《Group progress & self-regulation》 for the learners and 《Reinforcement》 for the mentors. Apparently, social interaction is the most important discourse for high school students on the web. Articles on 《Content knowledge》 and 《Group progress & self-regulation》 ranked the second and the third, which implies that the learners are diligent and motivated and the problem assignments were challenging to domain knowledge. The low ranking of mentors' effort on 《Reinforcement》 also verifies this derivation because it did not seem necessary. The mentors were by no means parsimonious in offering encouragements.

In contrast, mentors spent more time in prompting on the 《PBL model》 in addition to content knowledge, whereas the learners didn't care too much about it. The issues on 《methodology in science》 were the least brought up actually revealed its unfamiliarity to the high school students. They were generally insensitive to the methodology issues. However, the low frequencies on 《Network》 and 《Database of primary sources》 seemed to reflect the learners' proficiency in accessing network and the CD database of the primary content knowledge sources. The GeoSchool user interface was friendly and the one-day workshop on the operational skills at the beginning was effective.

4.4.2 The Threads

Table 3. The Distribution of Elicited Discourse Threads

No.	Category	# of Threads	Percentage of Threads	Total posted articles
3	Social interaction	60	37.3	494
6	Content knowledge	59	36.6	573
7	Group progress & self-regulation	26	16.1	172
1	Network	9	5.6	52
2	PBL model	4	2.5	36
4	Database of primary sources	2	1.2	13
5	Methodology in science	1	0.6	6
Total		161	100.0	1346

In order to explore what kind of interactions the learners were interested in, we traced the part of discourse that are sustained more than 5 round of responses. The ranking of the categories of threads is almost the same as the classification of the learners' articles as shown in Table 1. These threads covered 1346 articles, which is 50.1 % of the total. An average of 8.3 posted articles per thread were categorized across the seven categories as shown in Table 3.

4.4.3 The Questions Raised

Table 4. The Distribution of the Questions Raised

No.	Category	Frequency	Percentage
6	Content knowledge	196	37.4
7	Group progress & self-regulation	141	26.9
3	Social interaction	114	21.8
1	Network	28	5.3
4	Database of primary sources	17	3.2
2	PBL model	15	2.9
5	Methodology in science	13	2.5
Total		524	100.0

The biggest category of the questions raised is 《content knowledge》. It appears that the learners were involved in the justification of their own responses or in the evaluation of other's responses while operate in a self-prompting dialogic mode. The second biggest category of the questions raised, 《Group progress & self-regulation》, is referred to plan, monitor, and evaluate progress, divide responsibilities, manage procedures and affect as well as task completion. It seems that the network-based environment provide a convenient channel for coordination. The third biggest category 《Social interaction》 reveals needs of interaction and entertainment on learning which were not allowed and encouraged in traditional classroom environment.

4.4.4 Strategies Mentors Applied with Effect

Table 5. The Strategies Applied by Mentors in Scaffolding 《Content Knowledge》

Item	Strategy	Frequency	Percentage
H	Answer directly	43	37.4
A	Ask back	25	21.7
E	Suggestions & hints	16	13.9
C	Remind their prior experience	10	8.7
G	Pretend to be a peer learner	6	5.2
D	Give examples & draw an analogy	6	5.2
B	Ask question back to create a conflicting situation	5	4.3
F	Illustrate terminology	4	3.5
Total		115	100.0

Among 342 articles posted by the mentors, 223 (65.2%) were justified to be helpful. Table 5 shows the strategies with effect applied by mentors in scaffolding discourse of category 《Content Knowledge》. Not surprisingly, the guided prompts that with significant effects were 《Answer directly》, while 《Give examples & Draw an analogy》 and 《Ask question back to create a conflicting situation》 were less worked.

5 DISCUSSION

Although there have been some insightful studies examining collaborative learning in science (Coleman, 1998; Edelson, Gordin, & Pea, 1999; Krajcik, et.al.,1998; Lin, et.al., 1999), few have attempted to investigate whether the formation of network-based learning community will promote learners' reflective practice or ability of inquiry. This study sought to document a rich description of the social discourse under the Geoschool environment in order to understand the impact of a network-based environment on social discourse in science learning. Following issues deserve further discussions on the interpretation of out results.

5.1 The interpretation of the percentage of the categories.

One of the purposes we classify learners' posted articles into categories is to discover the characteristics of the learner's interactive process and the behavior pattern of the inquiry based learning of high school students.

At the beginning of the study, we thought the percentage of each category represented the importance of it. We found that the three largest categories collectively accounted for almost 86% of all posted articles categorized. The rests were on 《Network》, the 《Database of primary sources》, the 《PBL model》, and the 《Methodology in science》. They were fairly evenly distributed over the remaining smaller categories.

However, cross-referenced by other artifacts, we realized that inquiry did pose many challenges for learners. Among the challenges, the use of the database of primary sources and the familiarity of inquiry skills are the most difficult ones. In short, being small does not mean that the smallest categories can be ignored. On the other hand, the smallest percentages should be interpreted as the reflection of learners' limited experience and inability to elicit discussions.

5.2 The effects of discourse with mentors

The effects of mentor's role in the social discourse of learning can be further elaborated in the following ways:

First, the existence of mentors has impacts on learners' motivation. One learner wrote: "We've got to think of some insightful questions to ask the mentor, otherwise our group would be looked down upon by her (group E #120)." Reflecting on and articulating explanations on the web, from one perspective, is much the same as that in front of others. That places the inquiry on the table and leaves it open to evaluation and criticism. This is a characteristic of the discourse in the network-based community.

Second, the mentors in the social discourse present a sense of certainty and authority for the learners. One learner wrote: "I just transformed data into a figure. I would like to share the finding with you. I'm afraid that you would think that I'm an idiot because my score on Earth Science is B at school. The finding might be just wrong. I'm looking forward to your comments (group E #551)."

Third, reinforcement is another effect the mentors can have on the learners. Different from the scaffolding provided by technology, mentors are sensitive to the quality of inquiry and can be more encouraging to the learners.

5.3 The unhelpful scaffolding Styles

Sustained inquiry should be a key element in science learning. There are several styles of scaffolds that proved to be ineffective.

First of all, the responses with scandal connotation would be of absolutely no help. One mentor wrote: "hello, hello, I don't think you are the kind of people who accepts others' opinion without reasons. ... Pick your brain, otherwise it will gather spider web.

Besides, some mentors are very enthusiastic in helping learners whenever they got stuck. One mentor wrote: "I am so impressed by you guys' sustained discussion. I can't help but prompting something. ... Try to think about ... Then how about ...Why not..." The pattern described above is to raise several questions continually. The effect of this kind of scaffold is usually followed up by no further response. The reason for such a failure can be seen from at least two aspects. On one hand, the learners usually doesn't like to answer so many questions at once; on the other hand, the mentor provides the prompt at a time when learners are not in need. Therefore no further discussion would emerge. Many threads were ended up with mentor's big talk, which didn't facilitate the inquiry process but in effect killed it.

Interestingly, in the category of 《Reinforcement》, we can also find some unhelpful scaffolds. For some aggressive mentors, affirmative comments quite often followed by mentor's expectation of higher-order inquiry skills on learners. For example, the learner might be asked to provide further justification or reconcile what they know and do not know. This kind of reinforcing style also threatens the learners.

5.4 When does the meaningful learning occur?

It is difficult for the mentors to realize when was it appropriate to offer a prompt. The answer can be found by examining what these learners were actually doing during their natural unguided discussions. We found that later intervention is better than earlier intervention. However, with no intervention at all, the peer learners might encounter difficulties accepting one another's point of view and might not be able to overcome conflicts before giving up. The excerpts below are two learners' discourse in such a case (group D#342-347).

Learner A: Let's propose hypothesis#3 as "Both 'Spring-rain stationary front' and 'Mei-yu stationary front' cause weak upward convective motion.".

Learner B: I think this hypothesis should be modified as "'Spring-rain stationary front' causes strong upward convection; while 'Mei-yu stationary front' causes weak convection." What do you think?

Learner A: Why?

Learner B: It makes more sense from what I know.

Learner A: We can still stick to the original one and continue with the derivation. If the final result turns out to be wrong, we could just overthrow the hypothesis later on.

Learner B: No comments ... Shouldn't we make assumptions with as much sense as possible instead of groundless wild guesses?

6 CONCLUSIONS

As a tailpiece, it is worth commenting on the analysis of posted articles on the web. To explore the authentic interactive process of learners, we classified 2865 posted articles. It was a time-consuming task. However, it was this process of classification that uncovered the underlying interactive dynamics among the members of the network-based learning community.

Apparently, the influences of social discourse on science learning were multi-faceted. In the social discourse, the learners' were motivated, timely encouragements were provided; scaffolding was also facilitated for their understanding of content knowledge. However, inappropriate scaffolding styles could turn into just the opposite.

The percentages of the social discourse in the categories reflect the learners' initiation on aspects of learning activity, however, they do not imply the importance of the categories in the learning process. Low percentage of a category could be caused by the difficulties of inquiry skills and reflective practice encountered by the learners in the discourse. Therefore, a comparison of different group dynamics warrants further study.

ACKNOWLEDGEMENTS

This work has been supported by the National Science Counsel under the Grant NSC 88-2511-S-008-002 and NSC 88-2511-S-008-006. We owe our sincere acknowledgement to all the researchers, participating teachers, and research assistants in the GeoSchool Project for their crucial contributions. Finally, we owe a special thanks to Professor Tse-Liang Yeh, who continually and willingly gave his time to view the manuscript and provided us with his expertise, advice, questions, and support.

References

[1]Coleman, E.B. (1998).Using explanatory knowledge during collaborative problem solving in science. *Journal of the Learning Science,* 7(3&4), 387-427.

[2]Edelson, D.C., Gordin, D.N. & Pea, R.D. (1999). Addressing the challenges of inquiry-based learning through technology and curriculum design. *Journal of the Learning Sciences*, 8(3&4), 391-450

[3]Kagan, S. (1994). *Cooperative Learning*. CA: Resources for Teachers, Inc.

[4]Krajcik, J.,Blumenfeld, P.C., Marx, R.W., Bass, K.M., Fredricks, J, & Soloway, E. (1998). Inquiry in project-based Science classrooms: initial attempts by middle school students. *Journal of the Learning Sciences*, 7(3&4), 313-350.

[5]Lin, X., Hmelo, C., Kinzer, C.K., & Secules, T.J. (1999). Designing technology to support reflection. *Educational Technology Research & Development*, 47(3), 1042-1629.

The Artistic Interface - A Transition from Perception to Screen

Peter D Duffy
Queensland University of Technology
66 Harts Rd, Indooroopilly, Brisbane, Qld 4068
p.duffy@kormilda.qld.edu.au

1 Introduction

At present a dichotomy of computer art instruction exists, where the computer as an art medium, presents the learner with almost limitless possibilities of image manipulation; yet instructional methodology and current art curriculum provide no coherent framework through which the learner can effectively access this information.

2 Research

Throughout the last five years the researcher has taught numerous art concepts and involved students in art tasks using the computer. The reality of the researcher's teaching situation is that the use of the computer within an art context is not debated, but accepted as a part of the everyday teaching process. After several years and testing different ways of approaching the teaching of computer programs several issues emerged which warranted further consideration:

1. Frustration exists due to the limited time that students had available to use the computer and the amount of information students were expected to utilize.
2. Many computer graphic programs are structured in similar ways (display a similar interface) and use similar symbols (icons) to represent functions within the program
3. Students seem unaware of these similarities and unable to transfer an understanding of one programs GUI (Graphic User Interface) to another computer graphic program.
4. Students appeared to have no mental map or problem solving strategies with regard to searching for answers to problems within a computer art environment.

These thoughts led to the intention within this research study which is to document the qualitatively different ways that students interact with the graphic user interface of computer graphic software in an art education context in order to create art.

It is hypothesized that students need to build some form of mental model regarding the software program they are interacting with in order to understand its application domain. That by examining the influence of different types of interface cues regarding navigation within a computer art context a greater understanding of students' conceptions regarding utilizing the computer as an artistic medium could be facilitated. Interface cues in this regard pertaining to the icons, layout and menus presented to the user. This is defined by the researcher as the Artistic Interface. This Artistic Interface is the interaction that occurs between the student's artistic intent and the graphic user interface of the computer.

The underlying art educational assumption here is that the clearer the mental model the student has, the more capable the student will be at understanding the program, at locating a specific function and achieving the desired artistic result. Within the context of this study it is postulated that students with a clearer mental model of the graphic user interface (GUI) will have a more effective art educational experience (a more effective Artistic Interface) when utilizing the computer as an artistic medium.

In order to develop this 'mental model' a phenomenographical mode of inquiry will be used. Roth and Anderson (1988) stated that they consider learning to be a change in one's view of some phenomenon. Also Marton (1992) suggested that: "In order to develop teaching methods that help students arrive at new understandings of a given phenomenon, we must first discover the finite ways individuals may understand that phenomenon. Then, through experimentation, we may discover the most effective ways to bring students from a given conception to another, more advanced one, that is, from 'misunderstanding' to understanding." (p.253) Thus if students' conceptions of how they interact with the computer in an art educational context can be documented, then a learning framework could be developed which could enhance their understanding of the GUI of a particular program, and maybe other computer graphic programs.

3 Educational Considerations

Within a consideration of the influences of the GUI this study situates itself into the line of those devoted to the analysis of a possible correlation between the user's cognitive skills and his / her navigation abilities in an interactive, iconic, multimedia environment. This has been supported and further documented by Castelli, Colazzo, and Molinari, 1994; Elm and Woods, 1985; Osborne, 1990; Thuring, Hannemann, and Haake, 1995.

An effective analysis of students utilizing the computer in art education must begin with 'what is the student trying to do? Previous studies (Elm and Woods, 1985; Osborne, 1990) have demonstrated that getting lost is a consequence of the lack of a clear conception of the relationships within the system. In relation to this study this statement seems to imply that an effective use of the computer as an artistic medium depends upon the ability of the user to abstract from the system display discrete understandings relevant to the desired artistic result and that this may involve building a conceptual representation of a particular software programs GUI. It is further postulated within this study that if a learner can construct an effective mental map, or conceptual representation of a particular software programs GUI then this mental map maybe facilitate an easier and more effective understanding of another program due to the similarities in their GUI.

4 Conclusions

There is ongoing educational debate about the nature of the information society and the range of 'literacy's' needed to handle, understand, and communicate information in a variety of forms (Baker, Clay and Fox, 1996). The researcher has suggested that literacy in the information age requires not only the skills to operate the technology, but also the ability to identify and structure a line of inquiry in order to solve a particular problem. In this instance what is being analyzed is the range of 'literacy's' needed to form a line of inquiry into a computer art domain.

This research into the Artistic Interface is an attempt to document students' understanding of differing computer graphic arbitrary symbols (a software programs vocabulary) placed according to a systematic formula (a software programs grammar) to produce an understanding of various icons (pictograms used to represent a function of the computer). The researcher will seek to examine the qualitatively different ways that students understand the GUI in a particular computer graphic program and within a particular art educational context. This will involve a phenomenographical study that will lead to further understandings regarding students' perceptions of the Artistic Interface.

References

[1]. Baker, D.A., Clay, J., and Fox, C. (1996). "Challenging ways of knowing in English, maths and science". London: Falmer Press

[2]. Castelli, C., Colazzo, L., and Molinari, A. (1994). "Ht-Dedalus: Analysis of some models of hypertext performance". EC Newsletter, 6(1), 15 - 27.

[3]. Elm, W.C., and Woods, D.D. (1985). "Getting lost: A case study in interface design". Human Factor Society, 927 - 931.

[4]. Marton, F. (1992). "Phenomenography and "the art of teaching all things to all men"" Qualitative Studies in Education, 5(3), 253-267.

[5]. Osborne, D.J. (1990). "Browsing and navigation through hypertext documents: A review of the human-computer interface issues". Interactive Multimedia, 1, 3-32.

[6]. Roth, J.J., and Anderson C.W. (1988). "Promoting conceptual change and learning from science textbooks". In P.Ramsden (ed.) Improving learning: new perspectives. London: Kogan Page.

[7]. Thüring, M., Hannemann, J., and Haake, J. (1995). "Hypermedia and cognition: Designing for comprehension". Communications of the ACM, 38(8), 57-66.

The Design of CAI with Thinking Activity to Progress Constructive Teaching
- An Example of Division-concept in Mathematics of Elementary School

Pou-Yah Wu*, Mei-chueh Shao, Kai-Ren Chen, Ying-Xin Zhong, Ting-Wei Lin and Cheng-Wei pan.
Department of Mathematics Education, National Tainan Teachers' College, Taiwan
**Pou-Yah Wu's e-mail:pywu@ipx.ntntc.edu.tw*

This study aims at establishing a computer assisted learning system of division-concept of networked elementary school mathematics course based on constructivism and stress on students' thinking activities. It explores how students' thinking manifest on network, how the thoughts of the learner and those of the students on-line transfer, and how the thinking of the virtual students' solving problems reflect, so as to develop a set of CAI system about constructive pedagogy. In the system, we provide the learners with diverse tools for thinking activity, letting him/her choose what he/she needs to solve problems. We use network technology to simulate the real learning situation and to make the learner and the user on the line and the virtual students to communicate and discuss immediately. By setting up the CAI system that is compatible with the mathematics education of the elementary school in Taiwan now, we expect the learner to establish the right concepts positively so as to attain constructive pedagogic concept.

Keywords: **Constructive pedagogy; Division of Mathematics; Elementary School; Networked CAI; Thinking Activity.**

1 Introduction

The course design of pedagogy in Taiwan before 1993 is based on objective theory of knowledge. However, the pedagogic design ignores the complex and interactive phenomenon practically. Therefore, mathematics of elementary school in Taiwan in 1993 adopts pedagogic theory of constructivism [6]. Constructive pedagogy improve the shortcomings of the traditional pedagogy; but it also cause the deficiency of pedagogic duration owing to the orders of discussion and reflection in case it is put into practice in the real pedagogic environment. With the popularity of network, provided constructive concepts are applied to the learning environment of network, CAI effect would be promoted further. This study aims to design networked pedagogic environment matching "basic division-concept in mathematics of elementary school" by the learner's thought, using network technology, letting the learner have an environment to learn at home. The traditional CAI system neglects the positive learning and the interaction between the learners. So, we take into how to facilitate the interactive relationship between the system and the learner. Through the transmission of the networked thought, the learners can real-time communicate, making up a whole constructive learning environment, hoping to attain the constructive pedagogic concept.

2 Principles of system establishment

2.1 Basis of learning theory

The pedagogy of constructivism lies in stressing "knowledge is constructed positively by the learner", so that pedagogic design should arrange activities of learning-orientation. In the process of learning, the teacher serves as "problem poser" whereas the students acts as "problem solver"; the teacher plays the role of assistance, and the learner should construct knowledge positively through the interactive discussion between the learners [2]. Each learner utilizes his previous concepts to expound the phenomena around, and then comes up with adjustment or assimilation toward his acquired cognitive structure to establish new concepts. Besides, the learning situation is also an important part of the content, functioning to help the learner to comprehend the differences between the perspective on conceptual traits. Thus, the learning activities ought to provide learners with quasi-actual experimental situation to manipulate, explore. By means of the cognitive conflict brought about by the students in the process of the activity, challenging his original concepts, he/she constructs the right concepts via the discussion and coordination with one another.

2.2 Basis of course content-concept of division

Division is the anti-calculation of multiplication. Both multiplication and division are thought of as the transformation of unity quantity. The so-called "transformation of unity quantity" refers to that using unity quantity as that described by calculating unit, transforming to another description by calculating unit using another unity quantity [1,3]. The situational mode of division question is categorized into two basic principles of including division and even division. Seen from the viewpoints of "transformation of unity quantity" to look at the questions of multiplication- division, the questions of multiplication is to reduce the quantity suggested in the units of higher layers (units accumulated by several units of lower layers) to the activity of transformation from the quantity suggested by units of lower layers; whereas the questions of division "including division" is on the contrary, that is, the quantity suggested by the units of lower layers changed into the transformation activity by the quantity suggested by the units of higher layers. As to even division, it is an activity of new unity quantity of high layers and unknown unity quantity.

2.3 Foundation of system establishment

This system is a learning environment constructed on the network, adopting three-tier client/server system architecture, and meaning adding a layer of service server on the original client-server two-tier client/server system architecture. In the structure of three-tier client/server master-slaver, the part of management of learning data is in the charge of database server, web server takes charge of teaching jobs, while the users of client proceed all kinds of learning activities via browser.

3 Pedagogic design of networked construction

3.1 Pedagogic design of constructive division of new course

The two questions types of division (including division and even division) should be reckoned as different ones, then helping students combine these two types of questions gradually. And by the activity of consecutive subtractions solving questions to communicate with the relationship, then introducing the format of division calculation. Thus, in the design of pedagogy, place the two combined types of characters, letting children solve problems by tangible objects or emblems and try to record the activity of solving questions. After solving the questions including division and even division successfully, try further to grasp the times of distribution including viewpoints of division when confronted with them again [4,5]. The number of unity quantity can be decided by the times of distribution to help students realize and construct the relationship containing two types of questions as to including division and even division. Finally they can introduce the processes of solving questions concerning the methods of many-steps subtraction recording including division and even division and discuss and form the formulas using " ÷ "taking notes of the common sense about the activity of solving questions including division and even division, letting children construct the whole meaningful concept of division.

3.2 CAI pedagogic design of constructive pedagogy by thinking activity

This system emphasizes the spirit of construction to help students establish the concept of division, thereby, expecting the system to become more congenial to the real pedagogic environment. We let the computer become a virtual teacher, besides posing problems, he/she can judge the students' types of solving problems and mode of operation, and providing the dialectics and clarification and discussion undertaken between the users or between the user and the virtual students. Thus, the design of the problems by this system is introduced by the ordinary ones of daily situation to make sure if students have grasped the messages of the problems and communicate and clarify the messages with each other through asking (As in Figure 1). After posing the problems and clarifying the messages, let the students solve the problems. In order to make the system grasp the process of solving problems and thinking, we design "tool table of operation of thinking activity", which contain tangible objects, representation, digits and the symbol of calculations and so on. For example, as shown in Figure 2, if learner choose "to bakery", then the tangible objects can be used to solve the problems. If the learner choose "drawing circles", then representation can be used as the tools of solving the problems (As in Figure 3); if the learner choose "to digital factory", then digits can be used as the tool of operation (As in Figure 4). By the tool of operation chosen by the user, the computer can grasp what he thinks. If the user fails to solve the problems by themselves, they can discuss with others on the line, or discuss by the activity of solving the problems of the virtual students (As in Figure 6and 7) to attain the cooperation and learning. At last, after the user solve the problems successfully, the computer will play the role of the virtual teacher, raising questions to let the user to fortify the concepts, avoiding no continual between the user's order of thought and the concept (As in Figure 5). Then posing problems again to judge the students' learning state in order to proceed another activity dynamically. In doing so gradually, the system expects the learner construct an overall meaningful concept of division.

4 Architecture and implementation of system

4.1 Design environment and tools

This system uses Windows NT server as server platform. The developing languages include HTML, JavaScript, ActiveX, ASP (Active Server page) and so on. Using ASP as the main way of control, and exercising ASP and ODBC (Open Database Connectivity) to go with it, making the user's management of teaching material simplified. In the aspect of editing course software, Authorware5 is a chief developing tool.

4.2 System flowchart

The system flowchart we designs just as Figure 8 shows, the general elucidation is as follows:
1. Pedagogic situation of networked construction: In the beginning, the system would ask the user to register data to set up the database of students' basic data. At the outset of the course, the system will judge the user's competence by the pretest; then according to the basis, the system can pose the problems. After clarifying the messages of the problems, the system lets the user proceed to solve the problems. After solving the problems successfully, it lets the user carry on a series of on-line discussion and communication with the students or virtual students. Based on the acquired knowledge, the students construct the concepts, and fortify or revise the concepts through the experience of reflection. Again, the system poses the problems to judge the students' learning situation, then it proceeds the next teaching activity.
2. Database of "student model": It consists mainly of three databases:
(1) Database of students' basic data: It is used to record the students' basic data such as name, age, the experience of using the computer and so on.
(2) Database of learning: It is used to record the course units the students have learned, the learning state and duration of each unit, and the students' learning results and so forth.
(3) Database of learning achievement: It records the students' assessment about answering and the mode of students' operation.
3. Database of "posing problems of constructive pedagogy": It stores the material content of division pedagogy. The content contains two types of division problems (including division and even division) and various types of processes pedagogic activities.
4. Database of problems: It stores the problems for pretests and posttests.

4.3 Function of on-line communication

Because the system aims at establishing a more compatible with the learning environment of real pedagogy, so that this system design a series of communicative mechanism on the line to help students proceed the learning activities to produce the learning effect. The details will be narrated as follows:
1. Group of discussion: It is an open but not synchronized function on the line. Once the user encounters the learning difficulty, he/she can put the problems on the discussion place, and when other users see them, they can put forth the ways of solving these problems.
2. Room for discussion: It is an open and synchronization for communication. This on-line unction can improve the fact that the single CAI system fails to undertake the defects of communication and discussion immediately. Take Figure9 for example, the user in the room for discussion can carry on the mutual discussion, communication to solve the problems with other users on the line for their learning difficulty.
3. On-Line call: This is a one-to-one synchronous communication way, enabling the learners to proceed one-to-one discussion and forward the brief introduction to other users on the line.

4.4 Operation flowchart for User

When the user enter the system by using browser for the first time, the system would demand the user to register, thereby getting the user's data to set up student model basic data for database, and letting the user accept the pretest to judge the user's level of operation, and recording the user's answering situation. Utilizing the user's answer for reference, modifying the connection dynamically, letting the user connect the courses properly. Afterwards, whenever the user enters the system, he has to register user name and password as the recognition. The system then will proceed next activity according to the user's previous record. When the user undertakes the learning activity, the system will take down the learning state each time, so as to analyze if the user's learning state will attain the expected aim and will be used as learning analysis.

5 Conclusions

With the approach of eased network age, the network will definitely become the trend. Thus, establishing CAI system on the network cannot be delayed. In the light of these, we hope the constructive pedagogy combine with network to make up for the deficiency of pedagogy, letting the learners have more learning space, so as to acquire the real mathematics concepts. This study proceeds to test by the pedagogic content of "division-concept" of elementary school, presently testing all the functions provided by the system, hoping to reassess pedagogic content and system in many months, looking forward to reaching the learners' interaction, fulfilling the pedagogic concept indeed, letting children construct whole mathematics concept.

References

[1] 甯自強, "單位量的變換(一):正整數乘除法運思的啓蒙", 教師之友, Vol. 34, No 1, pp. 27-34, (1993).

[2] 甯自強, "國小數學科新課程的精神及改革動向—由建構主義的觀點來看—", 科學教育學刊, Vol. 1, No 1, pp. 101-108. (1993).

[3] 甯自強, "單位量的變換(二)", 教師之友, Vol. 36, No. 5, pp. 35-44, (1995).

[4] 楊瑞智, "國民小學數學新課程中年級除法教材的設計"八十二學年度數學教育研討會,嘉義,台灣,pp.119-136(1993).

[5] 楊瑞智, "國民小學實驗課程整數乘除算則的教材處理",八十六學年度數學教育研討會,嘉義,台灣 pp.98-113(1997).

[6] 蘇育任, "建構主義式教育的迷思與省思", 國民教育集刊, No. 5, pp. 121-139, (1997).

[7] 吳博雅, 王偉仲, 謝堅, 曾彥鈞, 陳詩茹, 牛晉媛, "網路建構式電腦輔助教學系統之研究—以國小數學科面積基本概念爲例", 1999 中華民國 CAI 研討會論文發表, pp. 159-165, (1999).

[7] Dalgarno, B. Constructivist Computer Assisted Learning: Theory and Techniques. WWW. 21Oct. 1997. Available: http://services.canberra.edu.au/~barney/articles/ascilite96/paper.htm (1997)

[8] Hiltz, S. R. Teaching in a Virtual Classroom. 1995 *International Conference on Computer Assisted Instruction ICCAI'95* Hsincku, Taiwan http://it.njit.edu/njIT/Department/CCC/VC/Papers/Teaching.htm

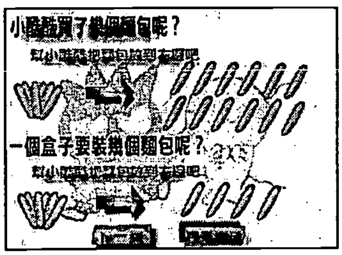


Figure 1:The Clarification of the problem

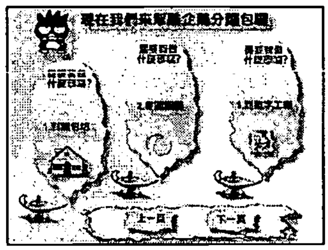


Figure 2:The choice of operation tool of problem solving

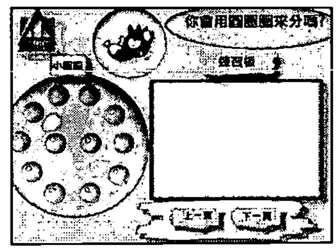


Figure 3:The presentation of thinking activity - representation

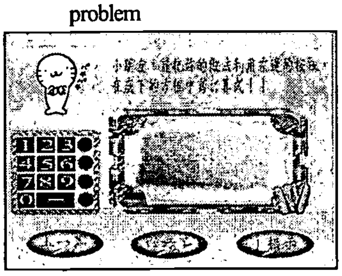


Figure 4:The presentation of thinking activity - digital and operator symbol

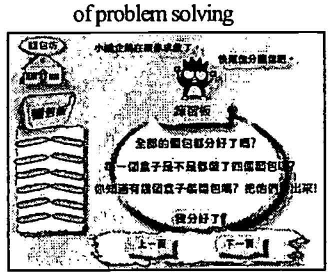


Figure 5:Reflection and discussion

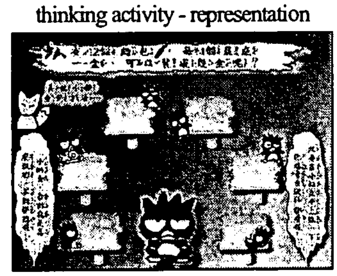


Figure 6:The strategies of virtual students

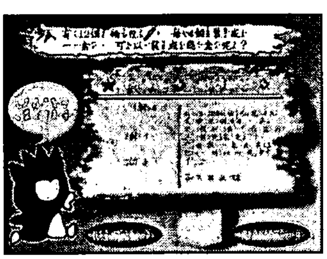
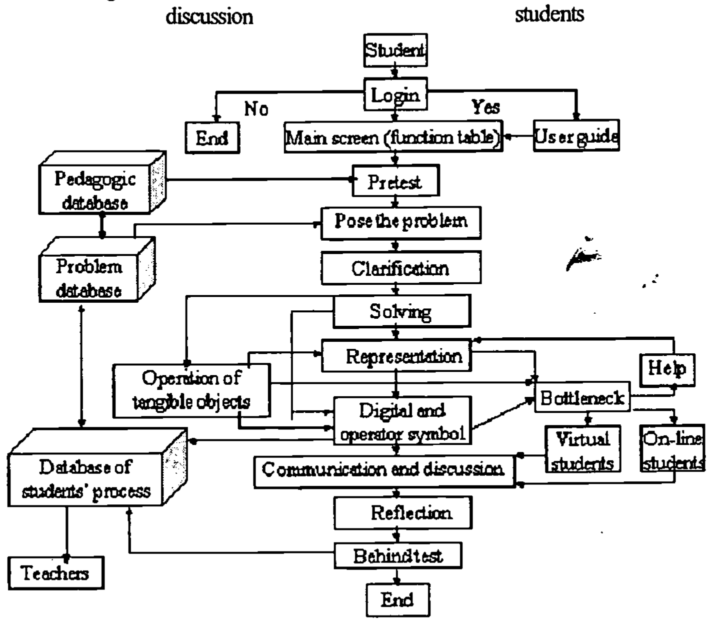


Figure 7: The communication of solving methods of virtual students



Figurre8: The design of networked constructive pedagogy with thinking activity

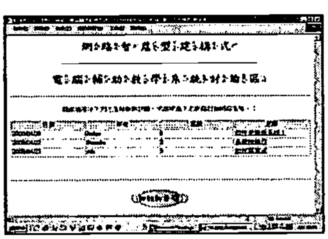


Figure 9: Group of discussion

The Discussion on the Dynamic Knowledge Generationand the Learning Potential Ability

Chao-Fu Hong, Chiu-e Chen*, Ming-Hua Hsieh, Cheng-Kai Huang and Shih-Hsiung Chang
*Aletheia University and Dah-Yuan Elementary School**
cfhong@email.au.edu.tw
No. 32 Chen-Li Str. Tamsui City Taiwan ROC
Tel: 02-26212121-5536

After we discussed with teachers to understand their instructional politics, we integrate the teachers' instructional politics, the process of knowledge generation, memorizing to construct the concept graph. Furthermore, we used the dynamic web pages to track the learner's learning and used the tracking data to reconstruct the learner how to construct his knowledge to understand the learner's thinking logic. In this paper we proposed the dynamic knowledge generation model and learning ability potential model. These were according to link the concepts to generate the knowledge. As following above idea we integrated the constructing materials and the dynamic knowledge generation to consist the expert system. The system would analyze his learning data to rebuild he how to build his knowledge, to understand his learning ability and he already built the whole knowledge or not. Rely on these results the system could supply the suitable materials to him for study. And the learning cycle would continue until the learner completely constructs the new knowledge into his ground knowledge. Finally, we could from proto type system to collect the experimental data and rebuilt the learner's learning steps, then followed the expert system to understand his learning ability potential. The system could supply a suitable material to him and help him to cross over the learning obstacle. These results also proofed that our model could really understand the learner's thinking logic and learning potential.

- Keywords: **dynamic knowledge generation, learning potential ability, concept graph, expert system**

1 dynamic knowledge construct process of learners

A meaningful learning must accord with three main conditions: Accepting the learning material, having the knowledge of dealing with learning material, and firing this knowledge at the learning time, (Mayer, 1975,1984). Accordingly, learning behavior has originality, creation and activity. It's easy to make learners to find the meaning of learning. If we want learners to have meaningful learning, we must do: "if you want to teach active knowledge for learners, you have to understand how to get the knowledge first. It's the same as you want to teach learners to think, you have to understand how learners think first." Therefore, if want to know the learner how to learn the knowledge, it can use the information process theory to discuss the human how to process his information like Fig.1. we design a structural material like a story, attaching pictures, and animations that attract learners. At the last section we give an additional problem among the units, which give learners integrating the prior knowledge. Then, the blind spot in every learner is obtained by using the model of a learning barrier analysis. The reason of inspiring learning barrier is obtained by using learners' browse web pages order and frequency. (Note: 3D learning barrier analysis) Meanwhile, learners will dynamically update their constructional knowledge network by learning number, browsing process, and test frequency. (Note: all of attributions of cognition nodes are dynamical.) Because learners are not static learning, we developed a dynamical model as Fig.1..

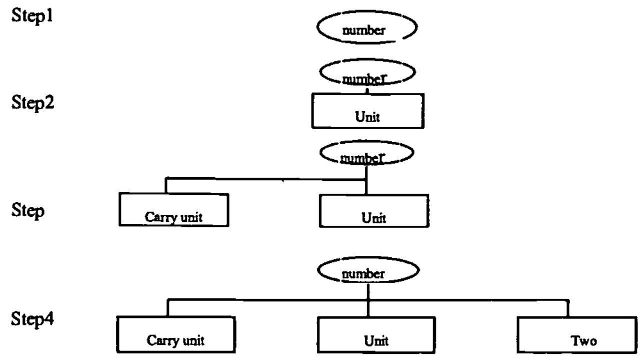


Fig.1 dynamic knowledge construct process of learners

2 the dynamical knowledge generation and learning ability analysis

In our model (**the model of dynamical knowledge generation and learning ability analysis**), using the teachers teaching experience, the system partition a judge learners' ability to achieve learning and the label of understanding course. And the Table1 is appropriate inference rule, what are the schools' teachers to classify the learners' learning ability.

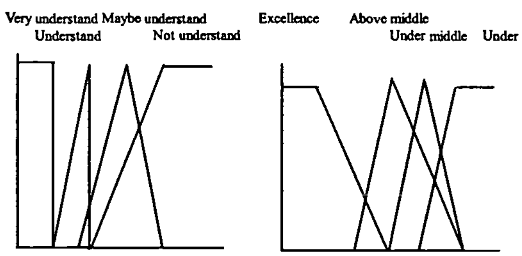


Fig.2 The relation of achieve a learning and the label of understanding course

Table 1. Inferring rule

TIMES / RESULT	UNDER	UNDER MIDDLE	ABOVE MIDDLE	EXCELLENCE
Cannot Understand	-2	-1	-1	0
Maybe Understand	-1	-1	0	+1
Understand	-1	0	+1	+2
Very Understand	0	+1	+1	+2

After the student had to go to the chapter's test. The testing results would according the learning obstacle analysis model to find his incompletely building knowledge and compared with the expert system to understand his learning ability. Finally, the system searched the suitable materials for him to study. The graph of learning cycle is shown in Fig. 3.

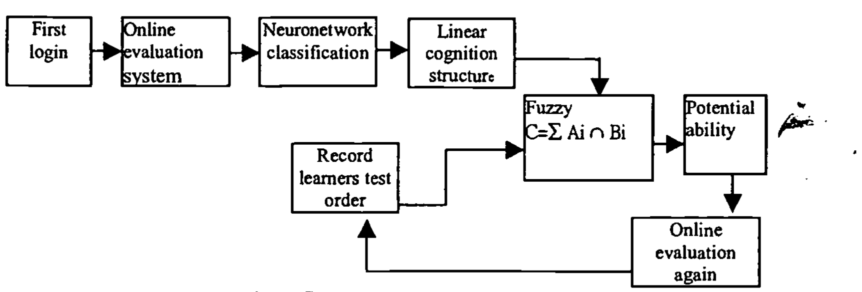


Fig. 3 System model chart

3 Conclusion

Although teacher can control his class ambiance and teaching trends, but he has many different individual learners in the classroom. If teacher cannot understand the learners how to learn and how to integrate their knowledge on his teaching, the teaching does not only let learner have a stuff learning, but also increase his teaching load. Therefore, in our paper we proposed "dynamical knowledge-generation model and learning ability analysis", to integrate the conceptual knowledge generation into structuring material and connect with the dynamical estimating expert's system. This system can collect what material learner had learned and the result of online testing was transmitted to the system. These real data used our analyzing model to decide his learning ability and supplied a suitable material to him for study. Thus, we believe our system do not only can help the teacher to understand learner how to build his new knowledge, but also can reduce the learner's learning barrier.

Reference

[1] Chao-Fu Hong、Yueh-Mei Chen*、Yi-Chung Liu、Tsai-Hsia Wu :Discuss 3D cognitive graph and meaningful learning,ICCE99

[2] Chao-Fu Hong、Yi-Chung Liu、Yueh-Mei Chen*、En-Yi Jen :Apply OO and T cell Cognitive Structurein Discovery Teaching,ICCE99

A Distance Ecological Model to Support Self/Collaborative-Learning via Internet

Toshio Okamoto
University of Electro-Communications, Graduate School of Information Systems
Choufu, Choufugaoka 1-5-1, Tokyo 182-8585
Tel: +81-424-43-5620; Fax: +81-424-89-6070
E-mail:okamoto@ai.is.uec.ac.jp

With the rapid development of information technology, computer and information communication literacy has become the main new ability required from teachers everywhere. For enhancing teaching skills and Internet and multimedia information literacy, a new teachers' education framework is required. Here we propose a Distance Educational Model, as a School-Based Curriculum Development and Training-System (SCOUTS), where a teacher can learn subject contents, teaching knowledge, and evaluation methods of the students' learning activities (subject: "Information") via an Internet based self-training system. We describe the structure, function and mechanism of the model, and then show the educational meaning of this model in consideration of the new learning ecology, which is based on multi-modality and new learning situations and forms.

Keywords: **Distance Education, Teacher Training System, Learning Ecology, School Based Curriculum Development**

1 Introduction

Recently, with the development of information and communication technologies, various teaching methods using Internet, multimedia appeared. Most of them emphasize, in particular, the aspect of collaborative communication between students and teacher during interactive teaching/learning activities. Therefore, now-a-days it is extremely important for a teacher to acquire computer communication literacy [1]. So far, there were many studies concerning system development, which aim at fostering and expanding teachers' practical abilities and comprehensive teaching skills, by using new technologies, such as computers, Internet, multimedia. In Japan, systems using communication satellites such as SCS (Space Collaboration System) are developed and used as distance education systems between Japanese national universities. In the near future, a teacher's role will change from text based teaching, to facilitating, advising, consulting, and his/her role will be more that of a designer of the learning environment. Therefore, a teacher has to constantly acquire/learn new knowledge and methodologies. We have to build a free and flexible self-teaching environment for them under the concept of "continuous education". At the same time, we build a collaborative communication environment to support mutual deep and effective understanding among teachers. In this paper, we propose a Distance Educational Model, which is based on the concept of School Based Curriculum Development and Training System, advocated by UNESCO and OECD/CERI (Center for Educational Research and Innovation), and describe the structure, function, mechanism and finally the educational meaning of this model. Based on such a background, it is necessary to construct an individual, as well as a collaborative learning environment, that supports teachers' self-learning/training, by using Internet distributed environments and multimedia technologies. A teacher can choose the most convenient learning media (learning form) to learn the contents (subject units) that s/he desires.

2 Distance Educational Model based on SCOUTS

Until now, when a teacher wanted to take a class on "IT-education", s/he had to leave the office or school. Now it is possible to learn various kinds of subject contents by building a virtual school on the Internet environment.

2.1 Distance Educational Model

Our Distance Educational Model is built on 3 dimensions. The first one is the subject-contents, which represents what the teachers want to learn. The second one represents the teaching knowledge and skills as well as the evaluation methods of the students' learning activities. From the third axis, the favorite learning media (form) can be chosen, e.g., VOD, CBR, etc. By selecting a position on each of the 3 axes, a certain cell is determined. A cell stands for a "script", which describes the instruction guidelines of the learning contents, the self-learning procedure, and so on (Fig. 1). In the following, I will explain the meaning of each axis in more details.

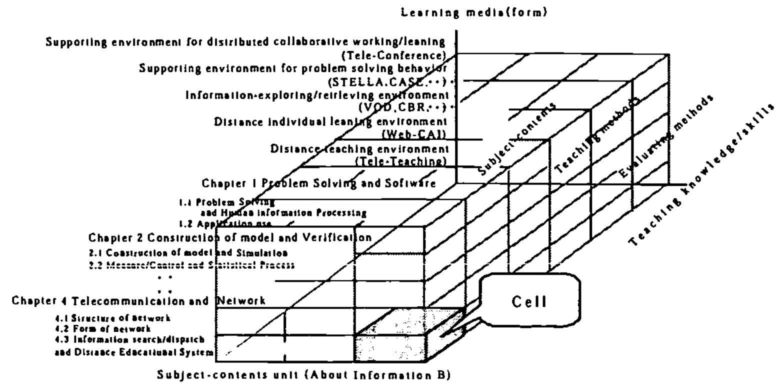


Fig.1 Structure of the Distance Educational Model

2.1.1 Subject –contents unit

In this study, we focus on the subject called "Information", which is due to be established as a new obligatory subject in the regular courses of the academic high school system in Japan. The subject "Information" is composed of three sub-subjects, "Information A", "Information B" and "Information C". The contents of each sub-subject are as follows.

Information A: raising the fundamental skills and abilities to collect, process and transmit "information" using computers, the Internet and multimedia.
Information B: understanding the fundamental scientific aspects and the practical usage methods of "information".
Information C: fostering desirable and sound behavior of participation, involvement and contribution in an information society; understanding peoples roles, and the influence and impact of technology, in the new information society.

2.1.2 Teaching knowledge/skills

On this dimension, we have represented sub-subject contents, teaching methods and evaluating methods for "information" classroom teaching. 'teaching methods' stands for how to use and apply IT, to enhance a student's problem solving ability, involving comprehensive learning activities, like problem recognition, investigation and analysis, planning and design, implementation and executing, evaluation, report and presentation. We aim at teachers acquiring the proper students' achievements evaluating skills, according to each of the above activities.

2.1.3 Learning media (form)

This dimension represents five different learning environments, as follows: 1) "Distance teaching environment (Tele-Teaching)" based on the one-to-multi-sites telecommunications 2) "Distance individual learning environment (Web-CAI)" based on CAI (Computer Assisted Instruction) using WWW facilities 3) "Information-exploring and retrieving environment" using VOD, CBR (Case Based Reasoning) 4) "Supporting environment for problem solving", by providing various effective learning tools 5) " Supporting environment for distributed collaborative working/learning" based on the multi-multi-sites telecommunications. Brief explanations for each environment are given in the following.

(1) Distance teaching environment (Tele-Teaching): This environment delivers the instructor's lecture image and voice information through the Internet, by using the real-time information dispatching function via VOD (Video On Demand).
(2) Distance individual learning environment (Web-CAI): This environment provides CAI (Computer Assisted Instruction) courseware with WWW facilities on the Internet.
(3) Information-exploring and retrieving environment: This environment delivers, according to the teacher's demand, the instructor's lecture image and voice information, which was previously stored on the VOD server. For delivery, the function of dispatching information accumulated on the VOD server is used. In addition to it, this environment provides a CBR system with short movies about classroom teaching practices.

(4) Supporting environment for problem solving: This environment provides a tool library for performance support, based on CAD, Modeling tools, Spreadsheets, Authoring tools, and so on.
(5) Supporting environment for distributed collaborative working and learning: This environment provides a groupware with a shared memory window, using text, voice and image information for the trainees.

2.2 • Cell" definition

The concept of a "cell" in the Distance Educational Model is quite important because it generates the training scenario, including the information to satisfy the teacher's needs, the subject materials learning-flow and the guidelines for self-learning navigation. The frame representation of the "cell" is shown in Table 1. These slots are used when the system guides the process of the teacher's self-learning.

Table 1 The frame representation of the "cell"

	Frame name	Slot-value
Slot-name	Learning objectives for a student	Subjects which should be understood Subjects which should be mastered
	Subject-contents	The unit topic
	Teaching method	The students' supervision method and instructional strategies
	Evaluating method	The students' evaluation method
	Useful tools	The software used for the training activity
	Operational manual of tools	The software operation method used for the training activity
	Prepared media	The learning media which can be selected
	Guide script	The file which specifies the dialog between the trainee and the system

3 Outline of the teacher training system

The system configuration of the teacher's training environment is composed of two subsystems based on the Distance Educational Model. One of the subsystems is the training system, where a trainee can select and learn the subject adequate for him/her guided by the script in the "cell". The other subsystem is an authoring system with creating and editing functions for "cell" description. The users of the second environment are, e.g., IT-coordinators or IT-consultants, who can design lecture-plans in this environment.

3.1 Training system

The training system aims to support teachers' self-training. The configuration of this system is shown in Fig.2. The role of this system is first to identify a "cell" in the model, according to the teachers' needs. Then, the system tries to set up an effective learning environment, by retrieving the proper materials for the teacher, along with the "guide script" defined in the corresponding "cell". Therefore, the system offers programs for both Retrieving and Interpreting. The training system works as shown in the following.

STEP 1: Record the teacher's needs.
STEP 2: Select a "cell" in the Distance Education Model according to the teacher's needs.
STEP 3: Interpret the "cell" in the guide WM (Working Memory).
STEP 4: Develop the interactive training with the teacher according to the "guide script" in the guide WM.
STEP 5: Store the log-data of the dialog (collect information on the learning histories and teachers' needs and behaviors).
STEP 6: Provide the needed applications for the user's learning activities and set up an effective training environment.
STEP 7: Give guidance-information, according to "cell" script guidelines, decide on the proper next learning step "cell".

The interpreter controls and develops the dialog process between user and machine according to the information defined in our "guide script" description language. This "guide script" description language (GSDL) consists of some tags and a simple grammar for interpreting a document, similar to the HTML (Hypertext Markup Language) on the WWW. The interpreter understands the meanings of the tags, and interprets the contents. An example of GSDL is shown below.

(1)<free>	*Definition: description of the text (instruction)*
(2)<slot (num.)>	*Definition: a link to a slot value in the "cell"*
(3)<question>	*Definition: questions to a trainee*
(4)<choice>	*Definition: branching control according to a trainee's response*
(5)<exe>	*Call: to relevant "cells"*
(6)<app>	*Definition: applications used for training activities (e.g., Tele-Teaching, etc.)*

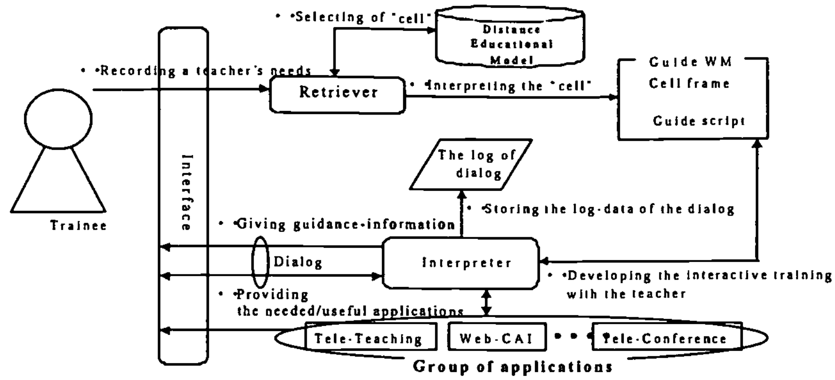


Fig.2 Configuration of Training system

3.2 Authoring system for creating and editing a "cell" description

The system provides an authoring module to create and edit the information in the "cell". This module also offers the function of adding new "cells", in order to allow supervisors (experienced teachers) to design the teachers' training program. The configuration of this system is shown in Fig.3. The tasks that can be performed by this system are: adding new "cells", editing the existing "cells", receiving calls for Tele-Teaching lectures, and managing the lectures schedule. This system is composed of the "cell" frame creating module, and the "guide script" creating module. A cell design can be performed as shown in the following.

STEP 1: Get the slot-values of "student's learning objectives", "subject-contents/teaching method/evaluating method", and "useful tools" from the "cell".
STEP 2: Substitute the return value of the slot of the prepared media with the training-contents corresponding to the user's needs.
STEP 3: Substitute the slot-value in the "cell" for the corresponding tag in the "guide script" template.
STEP 4: If "Tele-Teaching" as learning media is selected, then get some information about the lecture, by referring the lecture-DB and the VOD short movie-DB.
STEP 5: Add the new "cell" to the Distance Educational Model.

The lecture-database consists of "lesson managing files" containing user-profile data, lecture schedules, trainees learning records, lecture abstracts, and so on. The "guide script" template file contains tag-information, written in the "guide script" description language (GSDL), for all subject-contents items in the Distance Educational Model.

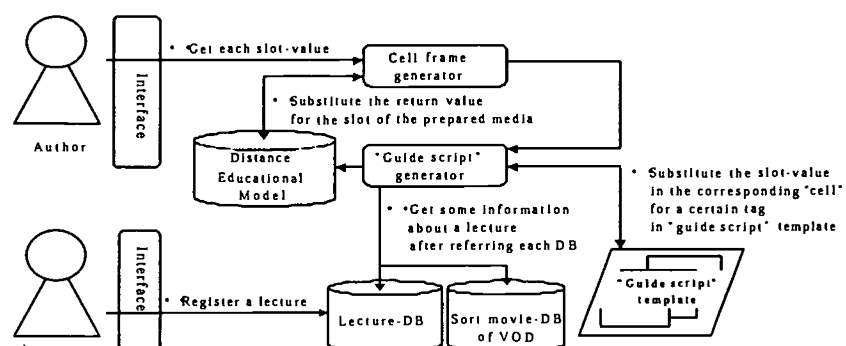


Fig.3 The procedure of "cell" description for creating/editing of the authoring system

4 Conclusions

This paper proposed the Distance Educational Model called the School Based Curriculum Development and Training System (SCOUTS). This model stands for the networked virtual leaning environment based on a three dimensional representation, which has on the axes 1) subject-contents, e.g., "information" for the training, 2) teaching knowledge, skills and evaluation methods and 3) learning and teaching media (forms). This represents a new framework for teachers' education in the coming networked age. We have mentioned the rationale of our system and explained the architecture of the training system via a 3D-representation model. Furthermore, we have described a "guide script" language. This system is superior to a simple rule-based instructional plan, as it allows a better and more natural overview of the global structure, as well as a quick identification of missing parts. The aim of our system is to support teachers' self-learning, provided as in-service training. At the same time, we need to build rich databases by accumulating various kinds of teaching expertise. In such a way, the concept of " knowledge-sharing" and "knowledge-reusing" will be implemented. As a result, we trust that a new learning ecology scheme will emerge from our environment.With this system, we can construct various kinds of learning forms and design interactive and collaborative activities among learners. Such an interactive learning environment can provide a modality of externalized knowledge-acquisition and knowledge-sharing, via the communication process, and support learning methods such as "Learning by asking", "Learning by showing","Learning by Observing, "Learning by Exploring" and "Learning by Teaching/Explaining"'. Among the learning effects expected from this system, we also aim at meta-cognition and distributed cognition, such as reflective thinking, self-monitoring, and so on. Therefore, we expect to build a new learning ecology, as mentioned above, through this system. Finally, we will apply this system to the real world and try to evaluate its effectiveness and usability from experimental and practical point of view.

References

[1]. Nishinosono, H.: A Teacher Education System for Information Education Teachers at High School Level in the Information Society. Proc. of the conference JET, pp.523-524 (1998)

[2] Collis, B.: Design, Development and Implementation of a WWW-Based Course-Support System. ICCE99, pp.11-18, IOS Press (1999)

[3] Seki, K., Takaoka, R., Matsui, T., Okamoto, T.: A Teaching Model in Distance Education based on Teacher's Needs. IEICE Technical Report, ET98-12, pp.49-56(1998)

[4] UNESCO Report: World Declaration on Higher Education for the 21 Century Vision and Action, Paris (1998)

[5] Salvador, L. G.: Continuing Education Through Distance Training. ICCE99, pp.512-515, IOS Press (1999)

THE GOOD, THE BAD, THE UGLY OR INTERACTIVE LEARNING ENVIRONMENTS

*Bobbie T. Biggs, Ph.D. and **James Swartz, Ph.D.
*bbiggs @comp.uark.edu and **jswartz@comp.uark.edu
*Professor and **Associate Professor
*Vocational & Adult Education and **Educational Leadership, Counseling & Foundations
*115 Graduate Education Building and **250 Graduate Education Building
University of Arkansas, Fayetteville, Arkansas, U. S. A.

Qualitative research methods of interview, observation, and document collection were used to analyze a three-hour (48 contact hours) distance education course. The research team consisted of a professor who was the instructor, an Associate Professor who taught qualitative research and five doctoral students enrolled in an advanced qualitative research class.

There were a total of eight learners in four sites. The learners consisted of a specialized population of male adults who were instructors at two-year technical colleges taking the class in response to a state mandate which stipulated that no one would be allowed to teach at the newly-created two-year technical colleges without a baccalaureate degree. The instructor was a female professor with about thirty-five years teaching experience and eight years experience with interactive compressed video distance education. Nine visiting guest speakers of varying teaching experience and no experience with interactive compressed video also participated.

Initial analysis indicated that strong teaching skills and classroom management skills were necessary to conduct the course. Far-site independence of movement, talk, and turn taking required special give and take between learners and the professor. Modifications of ordinary class behavior on the part of learners and the professor were noted.

Keywords: **Distance Learning, Classroom Environment, Classroom Management, Connectivity**

1 Introduction

The presenter's interest is not in distance education as a whole, but in the interaction between the qualities of distance education and teaching strategies for the professor and a particular set of learners. One of the research projects the presenter has completed in this arena was qualitative and the presenter was the subject of the research. The learners in the study were two-year technical college teachers, who were working on a bachelor's degree in vocational education. Since qualitative research is time and context bound, it is difficult to make inferences that would apply across time and context to all teachers who deliver instruction through distance education . That is, these distance education classes occurred in a specific context, with specific groups of people, in specific places, in specific situations, and at a specific time within the current guidelines of distance education technology. The significance of the research lies in the notion of transfer [9]. Transfer is the type of inference qualitative research uses instead of the quantitative notion of generalizability. Consequently, it is up to the reader to draw inferences about how the research time and context fits his/her own time and context. This is in direct contrast to quantitative research which makes decisions about the inferences generated by rejecting null hypotheses. Qualitative research is an appropriate research methodology because all distance education is conducted at a specific time, with specific people, in a specific place, and under specific circumstances [19]. Distance education is a practice rather than a laboratory setting; therefore, professors need to know more about the practice in a practical context-bound environment.

After eight years of teaching in a distance education classroom, the subject had many questions about what strategies were truly facilitating learning. There was also the question of whether a professor with more than thirty years of teaching experience in a traditional classroom could be successful in a distance education classroom. What were the similarities and differences between the classrooms? What issues would an experienced professor need to become cognizant of if he/she wanted to be a successful distance education teacher?

In qualitative research designs, the role of the researcher should be clear. Researcher roles range from participant observer to detached observer [15]. In this particular investigation, the researchers (excluding the subject) did maintain a role usually associated with detached observers. Their position was off camera in the back of the originating site. Although the researchers did travel to each site to observe and interview learners, the majority of observations were conducted in the originating classroom.

The primary observer, interviewer, and document collector was an Associate Professor who taught an advanced qualitative research seminar; the other five researchers were doctoral students in an advanced qualitative research seminar. The observations were overt in nature. The Associate Professor who was teaching the qualitative research seminar appeared on camera at the subject's invitation to introduce the research and inform the participants that their identities would be protected. Informed consent forms were sent to and signed by each person who participated in this research project, which included not only the professor and learners, but also guest lecturers and technicians.

Methods of assuring trustworthiness of the data were prolonged engagement, persistent engagement, triangulation, member checks, and peer debriefing [13]. Prolonged engagement means establishing a long enough contact with the object of research for the purpose of locating patterns in the data. Prolonged engagement was achieved to reveal patterns in the data as opposed to a collection of anecdotes. The entire distance education class was observed by one or more observers. Standardized open-ended interviews were conducted throughout the entire class; for example, three interviews were conducted with professor/subject and one interview was conducted with each class member. Documents were collected throughout the course at the same time the professor/subject distributed them to learners. Persistent engagement was achieved by constant analysis of the data as it were collected to establish patterns in the data and to exclude discrepant information which was anecdotal in nature. For example, sometimes learners who were present in the classroom with the professor might move closer to the professor to gain her attention. This was anomalous because the behavior was controlled for and was eliminated. Therefore, it was not a behavior that was a pattern throughout the course. Although possibly significant, it was an anecdote rather than a pattern. Data triangulation and researcher triangulation were also utilized to enhance the trustworthiness of the data. Data triangulation included observation of each class session, interviews with the professor, each learner, guest lecturers, and technicians. The instruction was documented through 48 hours of observation and approximately 30 hours of interviews with the professor/subject, learners, guest speakers, and technicians. Researcher triangulation was achieved through step-wise replication, which was a technique used during data collection. Step-wise replication is the use of multiple observers for the same observations. This technique was used in order to reduce the biases that might be present in any one single observer. Member checks were conducted with the professor because she was the focus of the research. A member check is a review by the research informant of interviews, observations, or documents. In the case of this particular research, the professor thoroughly reviewed interviews conducted with her in her role as a co-researcher. Peer debriefing was conducted by the six observers and interviewers at seven different meetings during the course.

2 Setting

The primary setting of the class was a state of the art distance education classroom at the University of Arkansas, College of Education and Health Professions. The classroom was designed for distance education and featured appropriate technical characteristics. The professor usually was seated at the front of the classroom behind a large desk approximately eight feet by four feet (8' x 4'). She also could stand behind or in front of the desk or sit at any table with on-site learners. The professor had three different cameras: one was mounted on a monitor (resting on an approximately 4' cabinet toward the center back of the classroom) which follows the movement of the professor; the second camera was attached to a monitor (resting on the same kind of cabinet as the monitors in the rear) to the professor's right as she looked at the classroom and pointed toward the class; and the third camera had the appearance of an overhead projector and conveyed printed materials much in the way an overhead projector would except through the compressed video system (ELMO). There was also a computer and a SmartBoard available. The professor used a wireless lavalier microphone. There were microphones shared between every two learners, which when turned on activated the learner camera. There were four monitors resting on the aforementioned cabinets; one 52 inch monitor which showed the professor the far-site learners and one 36 inch monitor which allowed the professor to view the near-site and two 52 inch monitors on one side of the professor for the learners to see near and far-site camera outputs. There was sound absorbing material on the wall, carpet on the floor, and neutral colored wall coverings around the room. Behind the instructor the wall was covered with a camera-blue paint for possible use of special effects. Seating for learners consisted of six-foot tables placed in rows to one side of the room with comfortable office chairs, as opposed to standard learner desks and chairs. Far-site classrooms had varying arrangements and color schemes.

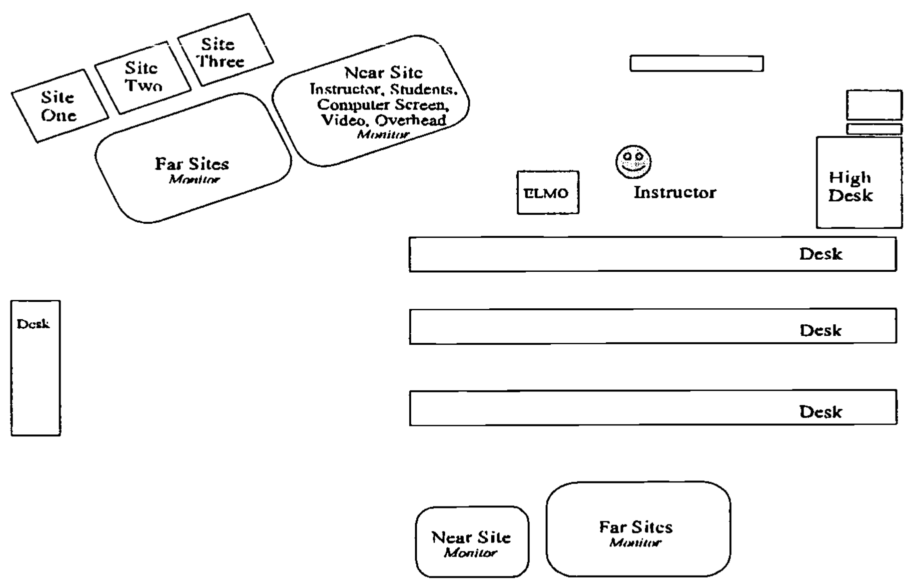


Figure 1. Distance Education Classroom

3 How the Technology Functions

There are four or five sites that combine to form the single distance education classroom. The professor was confined most of the time to the front desk in order to manipulate the controls for cameras and visuals. In her direct view were4 two large monitors, one side contained the camera feed for the near site while the other monitor showed the far sites. Only one far site could be viewed at a time. Selection of far-site location was voice activated; that is, if someone at a far site was speaking, the system automatically selected that site for viewing. Consequently, the professor could not select far-site locations for viewing at her discretion. Communication with learners was conducted through on-line compressed video imagery, world wide web, facsimile machine, electronic mail, standard U.S. mail service, and telephone. Of these options actual class time was centered around compressed video imagery. Guest speakers had been invited to convey information to learners during the courses. Each of the guests was provided the opportunity to view the professor as she modeled utilization of the system before the guest presented. It has been interesting to note that most guests expressed discomfort with the system, but subsequently seemed to work well with the system. Guests were never required to manipulate the system; the professor performed that function for them. Technical difficulties have been noted as part of the functioning of the system. Technical difficulties included feedback, problems with playback of videos, and interruption of compressed video signal due to weather conditions. All sites had some local technical assistance, though it was minimal.

4 Activities

The professor used a variety of interactive activities, such as lecture and questioning, self assessment, in-class individual and group work, guest lectures, learner demonstrations, individual and group reports, and cross-site dialogue — teacher to learner and learner to learner. A typical class period featured an introduction by the professor, which included personal exchanges with learners. Other attributes of a typical class session were professor lectures with visuals, which consisted of projection of the content on the ELMO or on the monitor from the computer such as a slide show presentation, continual questioning and clarifying, and short video tapes. The professor might introduce a guest speaker. The class session would then proceed to engaging the learner in activities, such as group work, learner teaching demonstrations, and presentation of learner reports. The professor also traveled to each far-site two or three times during the semester, depending on the need.

5 INTERACTION OF DISTANCE EDUCATION CHARACTERISTICS WITH TEACHING STRATEGIES

This section is really the heart of the story. The following table lists the differences and similarities between traditional classroom instruction and distance education instruction for this particular professor and a particular group of learners [10]. Although the table describes both similarities and differences, the emphasis today will be on what teaching behaviors the professor had to modify because of distance education. Modifications include those associated with environment, presentation of knowledge base, classroom management, nonverbal communication, feeling of connectivity among learners and professor, methods of communication, and technical problems.

Table 1

Similarities and Differences Between Traditional and Distance Education Instruction

Similarities	Differences
• **Environment conducive to the teaching-learning process** ○ Become just as frustrated when cannot talk immediately ○ Learners want to be part of class ○ Diffuse anger or frustration ASAP ○ Face to face ○ Can establish rapport, but takes more effort ○ Make each learner feel welcome, at home, and glad they came ○ Nurturing positive attitude	• **Environment conducive to the teaching-learning process** ○ Difficult to read nonverbal cues ○ Situations may require explanations because all learners cannot see all that is happening in each classroom ○ Teacher and learners have narrow perception of the classroom itself, because all there is is the screen ○ Exhaustion of teacher and learners due to length of class period and number of previous hours in class ○ Rapport is more difficult because learners must be brought along at each meeting as if it is a new class, as you cannot see faces and cannot tell where they are, so you have to assume no one is with you ○ Informality is more difficult to maintain when teacher is confined to one spot ○ May be more stressful to professor than traditional classroom
• **Presentation of knowledge base** ○ Extensive preplanning ○ Transparencies for focus ○ Relevance of material ○ Setting up a learning activity ○ Teaching blocks of 15-20 minutes ○ Refer learners frequently to text	**Presentation of knowledge base** ○ Size of visual materials ○ Color of visual materials ○ Lectures need to be visible ○ Speak more slowly ○ Operating equipment without distracting from content
• **Classroom management** ○ Recreational stress management — joking, getting them ready to engage with me; an organization process ○ Have to manage learners the same — if they are not on target or if they are going things you do not want done — always a constant ○ Make assignment, which is introduction for next class	• **Classroom management** ○ Easier for the teacher to become isolated and self centered and be the fountain of knowledge because it is easier to handle class that way ○ Length of time it takes for class materials to reach learners and learner work to reach me (if the web and e-mail is not used) ○ May have to hold something that needs immediate discussion, because it is not in the hands of all learners — makes spontaneity difficulty ○ Timely feedback difficult ○ Encourage learners talk more and/or to work in groups if we are experiencing audio problems ○ Model for guests so they see what happens when camera jumps from site to site ○ Difficult to do group work across sites because of sound interruption to other learners ○ Have to make special arrangements for private conversations ○ Takes more direction for guests, especially to have appropriate visuals ready and class materials to learners ahead of time ○ Physical proximity cannot be used to control a disruption — all there is is verbal proximity
• **Nonverbal communication**	• **Nonverbal communication** ○ Observation difficult due to camera focus and lack of camera control in multiple sites ○ Limited movement unnatural

Similarities	Differences
• **Feeling of connectivity among class members and professor** o Connecting with learners personally through acquaintances or experiences o Be who you are and operate the same o Call each individual by name o Let learners know who you are o Introducing learners; establishing expectations; setting the stage for involvement	• **Feeling of connectivity among class members and professor** o Look regularly at the camera o Treat each site as if it were an individual in a larger class; call each person by name when they speak or when called upon o Learners may feel isolation, especially near-site learners, because camera is usually on teacher; the fewer the learners, the more the isolation o Professor had to make notes on learner needs, because in jumping from screen to screen (classroom to classroom), easy to lose site of needs o Learners usually have trouble speaking — breaking in and speaking up and out
• **Attention to physical appearance** o Clothing, makeup o Enthusiasm, humor o Voice tone/pitch o Pauses o Gestures	• **Attention to physical appearance**
	• **Methods of communication and or interaction** o Facsimile machine o Electronic mail o U. S. Mail o Telephone o World wide web
	• **Technical problems** o Manipulation of equipment distracts o Feedback in sound system o No on-site technician for problems o Exhausting for professor to have one screen moving them from site to site; split or multiple screen desirable o Limited professor movement due to microphone, camera and controls; otherwise, technician must be in room o Disconcerting to jump from classroom to classroom o Camera focus too distant for reading nonverbal communication o Having to look at another camera to see where professor is in relation to monitor may make teacher look distracted when checking it o Determining if system will be back up when it goes down and what to tell learners about staying or going home

Environmentally, the primary difference is a two-dimensional far-site communication that is limited to the focal length of the lens. This limitation excludes detail, relevant off-camera occurrences, and access to a great deal of nonverbal communication. For example, on numerous occasions learners requested that the professor move her camera closer to her face so they could see her facial expressions. This greatly restricted the professor's movement and eliminated hand gestures and body motion that she normally used to provide emphasis. Such a restrictive environment often causes stress to professors and learners and makes rapport problematic.

Presentation of the knowledge base required more time to deliver because lectures needed to become more visible and the professor needed to speak more slowly. On one occasion the professor was discussing an overhead transparency point by point and a learner remarked, "Please slow down; I can't hear you that well through the system." The combination of lack of screen resolution that is characteristic of a television image and the poor sound quality required more time to deliver instruction. One of the reasons that sound and picture quality can be poor is the need to reduce the band width in order to match the distributor's system which does not always match the originating signal. In addition, a distance education professor's attention must be devoted to operating equipment as well as to delivering content. Frequently it takes longer to deliver instruction via two-way compressed video; therefore, it may decrease the scope of the course.

The majority of the differences noted between traditional and distance education instruction appeared in the classroom management category. Normally physical proximity can be used to control classroom disruptions. That is not available to the distance educator. It is extremely difficult to take a learner aside for private conversations. The professor did this primarily through e-mail and telephone communications. Although it is beneficial to plan materials and instructional sequences ahead of time, the lack of physical proximity to learners and the inability to introduce new materials rapidly reduces spontaneity of instruction. For example, a far-site learner might request information about a regulation concerning affirmative action, which involved completion of certain forms. The professor would have to get the forms to the learner before he/she could discuss the specifics of the question. This is one example among many about how physical distance from learners reduces opportunities for the teachable moment. Physical isolation from learners means that organization and direction of the class can easily become centered on the professor which could cause the professor to utilize more controlling teaching strategies. It should be mentioned that guest speakers needed to be encouraged to prepare further in advance for their presentations and also had to be introduced to the technology. This sometimes produces a much more formal presentation than was appropriate for the particular teaching situation. The principle investigator's notes in the verification study included references to the stiffness of the guests as they presented. A member check with the professor revealed that the same guests were much more relaxed during traditional classroom presentations.

Nonverbal communication suffered significantly because the camera sees so little and with poor clarity. For example, with three or four remote sites and only one site visible on the monitor at a time and possibly only one learner on camera, the professor could not gain nonverbal feedback from the class as a whole. Even when as many as three learners were on camera at a single time, the camera was so distant that few nonverbal cues, except those involving the whole body, could be observed; for example, facial expression or hand gestures were not readily conveyed.

The feeling of connectivity among class members and the professor is different in the distance education setting. The system used in the College of Education and Health Professions is voice activated which causes learners problems with taking turns, because when they speak the picture jumps to their location; therefore, it is difficult for cross-site discussions to take place. The professor had to use special strategies to establish a classroom community from the four or five sites. The professor approached the task of creating one classroom by recognizing the personality of each site and then the personality of each learner at that site. These personalities were a product of the individuals and the technologies they had at their disposal. For example, there was one group that expressed a reluctance to use the ELMO at their location, while other learner sites would not speak in order to prevent the camera showing their location.

Methods of communication controlled methods of interaction. In a traditional classroom the professor can take a learner aside for a personal conversation while others are working on individual or group projects. However, in the distance education classroom what one learner hears, all learners hear. Of the means of communication utilized in the class, only e-mail or the telephone offered the possibility of a personal conversation.

Technical problems sometimes eliminated class or disrupted class. For example, line feedback made verbal communication very difficult on numerous occasions. On one occasion a storm at a distributing site caused the elimination of one class period. Other technical problems included picture quality, problems with showing videos in real time, and limits on my movements. In spite of these differences between the traditional classroom and the distance education classroom, it is still possible for a class to be conducted on a regular basis and with favorable results.

6 Conclusions

This discussion of similarities and differences between traditional and distance education instruction has centered on the differences rather than the similarities. The researchers have heard many speakers state that there is no difference in teaching in a traditional or distance classroom. The professor knows from eight years of experience there is a difference and is trying to understand the nuances about distance education. The differences cited were classroom environment, presentation of the knowledge base, classroom management, nonverbal communication, feeling of connectivity among learners and professor, methods of communication, and technical problems.

The cumulative effect of these differences resulted in a reduction of what is being called social abrasion. Social abrasion means being present which implies physical proximity and the social abrasion that such physical presence produces [14]. For this discussion social abrasion has been separated into the following categories: physical distance, emotional distance, simultaneous two-way verbal and visual access, private communication, and local knowledge.

Physical distance is an important part of social abrasion. In western civilization each person maintains approximately a three-foot distance between their body and the body of other people. This distance is either reduced or expanded based on interactions with others [6]. The expansion and contraction of this physical distance is an example of the abrasion between one person and another. Abrasion means contact and social exchange. This abrasion is done socially through verbal and nonverbal communications. If people are separated physically as they are in distance education, this sort of social abrasion is extremely reduced or nonexistent because there is no three-foot parameter to expand or contract. Physical distance also decreases interpretation of nonverbal communication. In a long camera shot facial gestures are lost, hand gestures become smaller, and a coherent sequence of body movements become unavailable to the viewer.

Emotional distance is increased through the possibility of physical presence. For example, the threat of being physically harmed or the pleasure of being physically touched are eliminated through distance education. Emotional identification with someone who is simply an image on screen may be more difficult [1]. This is one of the reasons why the professor visited the far sites. Trust in part may also be a function of physical distance. According to some researchers [5], credibility is a product of appearance and personal identification and is problematic when mediated. Authenticity can be achieved by the handling of real objects and the sharing of those objects in a common space [8]. Personal narratives delivered by professors or guest speakers may be less realistic when conveyed through a medium normally associated with fantasy [1]. Simultaneous two-way verbal and visual access are standard in a traditional classroom environment but are not guaranteed in distance education especially when visual access is limited to one site at a time in a multi-site communication. Social abrasion also means the possibility of one on one private oral and written conversations. This is extremely problematic with distance education because what one person says is heard by all. Also important to social abrasion is the honoring of local knowledge [7]. It is possible that knowledge like bread is best make locally [17]. For example, the classroom experience and interpretation of the meaning of course content can vary from site to site [2]. Meanings can vary from site to site because different sites may represent clusters of people with similar experiences that are unique to their areas. For example, professors sometimes have a site which will consist of persons who work at the same industry and may be at different levels of authority within the organization. It is probable that their experiences and knowledge and their meanings differed from other sites [4]. The inability to bring everyone together in one location to produce a common discussion seems impaired by distance education. The combination of these elements — physical distance, emotional distance, simultaneous two-way verbal and visual access, and private communication — and the maintenance of distinct knowledge bases (local knowledge) throughout the course may mean that distance instruction produces different outcomes than traditional classroom instruction. It is these outcomes upon which the research focused. It is the findings of that research the professor draws upon as she develops courses and teaches via two-way compressed video.

REFERENCES

[1] Altheide, D. L. (1976). Creating reality. Beverly Hills, CA: Sage Publications.
[2] Anyon, J. (1981). Social class and school knowledge. Curriculum Inquiry, 11(1), 3-41.

[3] Biggs, B. T., & Swartz, J. D. (1997) Evaluation of an interactive compressed video distance learning class: What we learned from the study. *The New Learning Environment: A Global Perspective* [18th International Council for Distance Education World Conference Papers, CD-ROM]. University Park, PA: The Pennsylvania State University.

[4] Breton, R. (1984). The production and allocation of symbolic resources: An analysis of the linguistic and ethnocultural fields in Canada. Review of Canadian Sociology and Anthropology, 21(1), 123-144.

[5] Fleming, M., & Levy, H. (1992). Instructional method design (2nd ed.). Englewood Cliffs, NJ: Educational Technology Publications.

[6] Goffman, I. (1974). Frame analysis. New York, NY: Harper Colophon Books.

[7] Greene, M. (1986). Reflection and passion in teaching. Journal of Curriculum and Supervision, 2(1), 68-81.

[8] Leiter, K. (1980). A primer on ethnomethodology. New York, NY: Oxford University Press.

[9] Lincoln, Y. S., & Guba, E. G. (1985). Naturalistic inquiry. Beverly Hills, CA: Sage Publications.

[10] Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis (2nd ed.). Newbury Park, CA: Sage Publications.

[11] Orr, B., & Biggs, B. T. (1998). Distance education and two-year institutions — a match? ATEA Journal, 16 (1), 16-19.

[12] Orr, B., & Biggs, B. (1998). Issues and barriers in teaching through two-way compressed video. Refereed poster presentation at the 6th International Conference on Computers in Education. Beijing, China, October 14-17, 1998. [published in proceedings]

[13] Patton, M. Q. (1990). Qualitative evaluation and research methods (2nd ed.). Newbury Park, CA: Sage Publications.

[14] Polanyi, M. (1966). The tacit dimension. Gloucester, MA: Doubleday and Company.

[15] Strauss, A., & Corbin, J. (1990). Basics of qualitative research. Newbury Park, CA: Sage Publications.

[16] Swartz, J. D., & Biggs, B. T. (1999). Technology, time, and space or what does it mean to be present? Journal of Educational Computing Research, 20 (1), 71-85.

[17] Taylor, W. D., & Swartz, J. D. (1988). The emerging knowledge crisis in instructional technology. In M. E. Shorey & A. D. Evans (Eds.), Preparing educators with essential media competencies (pp. 141-152). Columbus, OH: The Ohio State Educational Library/Media Association.

[18] Wolcott, H. F. (1995). The art of fieldwork. Walnut Creek, CA: Altamira Press.

[19] Yin, R. K. (1994). Case study research: Design and methods. Newbury Park, CA: Sage Publications.

The process of learning programming: a comparative study of students' reactions

Judy Sheard*, Angela Carbone* and Selby Markham*
**Faculty of Information Technology*
Monash University
900 Dandenong Road, Caulfield East, Victoria 3145, Australia
Tel: +61 3 9903 2701
Fax:+61 3 9903 1077
Judy.sheard@infotech.monash.edu.au, angela.carbonne@infotech.monash.edu.au
selby.markham@infotech.monash.edu.au

The study of programming is fundamental to any university computing degree course, although many students do not intend to become programmers. This raises an educational question about what students perceive are the benefits of studying programming languages. Added to this is the question of how students compare one language to another. A search of the literature indicates that there appears to have been no research into a comparison of the teaching and learning processes of programming languages by the students learning them. This study attempts to open up this area by reporting on the experiences of a group of students who learnt Visual Basic and COBOL in sequential semesters in the first year of their undergraduate computing course. It showed that there were differences in the way students experienced the subjects but that these were not linearly related to pedagogical models.

Keywords: **Teaching and learning programming, Visual Basic, COBOL**

1 Introduction

Programming languages have been around for half a century. There are a plethora of programming languages which have been developed during that time, ranging from assembler languages to the currently popular object-oriented and visual languages. It is very interesting that a literature search has revealed many references on learning programming, but no comparative studies on student reactions to the processes of the teaching and learning of particular programming languages.

The study of programming is fundamental to any university computing degree course. It is generally recognised that this is a basic skill which is important for all computing graduates to have acquired. Of course not all computing students intend to become programmers, however as professionals working in the computing industry they may expect, at some stage in their future careers, to need some knowledge of programming. The amount of programming taught in a course depends on the focus of the degree, with some courses teaching a minimum of programming and only to an introductory level. This paper reports on a study of first year student experiences learning two different programming languages, Visual Basic and COBOL, in a degree in which programming is often not central to the interests of students. The study aimed to establish if students had a preference for either language and to determine reasons for their preferences. Data was collected through a survey designed to gauge the students' reactions to the learning of each language by asking them to rate the difficulty of concepts and the usefulness of resources provided.

2 Background

2.1 Course

The research focused upon the Bachelor of Information Management & Systems which is a three-year computing degree. It aims to prepare students for careers in the development and management of information systems. The focus of the degree is the study of information flow, information management, computer-based management systems, and systems analysis and design. Students study two subjects of programming, (Computer programming for business A and Computer programming for business B) in the first year of the course. These are the only core (compulsory) programming subjects in the course and were included to provide students with "background" concepts and skills necessary to effectively manage an information technology project. There are six elective subjects in the course and students may choose to study more programming subjects.

2.2 Programming subjects

The two programming subjects are studied consecutively in the first year of the course. These subjects aim to introduce students to commercial business application development. Students learn Visual Basic in the first subject and then COBOL in the second subject. They are both taught as introductory programming subjects, but with necessarily different flavours. Both subjects are taught over a 13 week semester, with a two hour lecture and a one hour tutorial in a computer laboratory each week. The subject details are as follows:

2.2.1 Computer programming for business A

Students are introduced to Visual Basic, currently a popular language for developing Windows based applications. They learn the syntax of the Visual Basic language and the basic programming concepts of types, sequence, selection, iteration, functions, arrays, and files as applied in Visual Basic. They are also introduced to the concepts of object–orientation, event-driven and visual programming. The emphasis in this subject is on developing interactive graphical user interfaces using an integrated development environment.

Assessment in this subject consists of 30% for assignment work completed during the semester, and 70% for a final examination. Students must pass the examination in order to pass the subject.

2.2.2 Computer programming for business B

Students are introduced to the most widely used commercial programming language, COBOL. They learn the syntax of COBOL and the basic programming concepts of types, sequence, selection, iteration, functions, arrays, and files as applied in COBOL. They are also shown fundamental processing algorithms including file validation and updating, report generation and control break processing. The emphasis in this subject is on understanding, designing and developing batch and on-line commercial processing applications.

Assessment in this subject consists of 20% for assignment work during the semester and 80% for a final examination. Students must pass the examination in order to pass the subject.

2.3 Research Design

The research project was seen as an exploratory study which was aimed to help open up an area of research into computing education. As part of the exploratory exercise, a number of behavioural and response variables were formulated into a questionnaire in addition to the material which focussed upon the programming languages. We could have taken any number of approaches to the behavioural and response variables but we chose to use that derived from organisational approaches to motivation, in particular those which take seriously the relationship between expectations and outcomes [6][14].

The survey tools had five sections covering biographical data, behavioural information, language specific ratings, course delivery ratings and two open-ended questions. All ratings a 7-point Likert scale. The language specific questions differed for Visual basic and COBOL. The biographical questions were designed to help establish a profile of the students and enable comparisons to be made between responses on the basis of things such as gender, previous programming experience and time spent on each subject. The open-ended questions asked for students to add additional comments about what they liked and disliked about the language covered by the questionnaire.

Data collection was carried out during the last week of semester of each subject. At this stage of teaching, every concept had been presented to them and they had completed, or were near completion of, their assignment work. All the students who attended classes during this week were given a questionnaire to complete. Participation in the survey was voluntary. Of the 92 students enrolled in Visual Basic 37 completed the questionnaire, and 43 questionnaires were completed the out of 84 students enrolled in the COBOL class.

3 Results

3.1 Student profiles

The students participating in the research were predominantly male (69%) which fits with the general profile for students doing programming subjects within the university.

For the Visual Basic subject, 57% of students had no prior experience with programming languages. The COBOL students (most of whom had completed the Visual Basic course) had 93% who had experience in at least one programming language. This can be seen as a low level validation of the student responses in that if there had been a low percentage of the COBOL students saying they had no experience with languages, the results would have been suspect.

The students doing these subjects are not in a computer science type of course and their access to a variety of technical software would be limited. It was of interest to the researchers to see how many students had the appropriate language compiler on their own computer. Of the students enrolled in the Visual Basic subject, 90% had access to the Visual Basic software at home. However, 74% of the students in the COBOL subject had access to a COBOL compiler at home and in most cases it was not the same one that was available at university. This may be seen as potential influence on their approach to the subject.

3.2 Subject content

There were no significant differences in student valuations of the amount of content or the difficulty of the content between both subjects. However the Visual Basic students claimed that they spent an average of 5.5 hours per week, including class time, on their subject. This is significantly higher than the COBOL students who claimed to have spent an average of 3.5 hours per week. This indicates that the Visual Basic students spent 2.5 hours outside class time each week whereas the COBOL students had only spent half an hour, an interesting result which will be discussed in Section 4 of this paper.

3.3 Subject pace

The mean and standard deviations of the student ratings of the pace of each subject are shown in Table 1. A t- test, which is a method of comparing the difference of means between two groups, showed that the pace of the Visual Basic subject was rated significantly slower than the pace of the COBOL subject. However, the students in the Visual Basic class with no prior programming experience found the pace significantly faster than their classmates who had previous experience with one or more other languages. This agrees with Liffick's [8] observation of novice programmers and Affleck's [1] study indicating the importance of prior knowledge of concepts and terminology when learning computer programming .

The mean and standard deviations of the student ratings of whether they had kept up with the subject are shown in Table 2. A t-test showed that the Visual Basic students felt that they had kept up with the work more than the COBOL students felt they had.

Table 1 Student ratings of the pace of each subject

	Visual Basic		COBOL		t
	Mean	SD	Mean	SD	
Pace of subject	4.7	1.1	5.3	1.0	-2.5/75*
* indicates t test results significant at p <=0.05					

Subject was very slow =1
Subject was very fast=1

Table 2 Student ratings of whether they had kept up with the work

	Visual Basic		COBOL		t
	Mean	SD	Mean	SD	
Kept up with work	5.0	1.3	3.7	1.6	3.9/78*
* indicates t test results significant at p <=0.05					

Fell very behind with the work =1
Kept up with the work completely=7

Table 3 Student ratings of the usefulness of subject resources

	Visual Basic		COBOL		t
	Mean	SD	Mean	SD	
Lectures	5.9	1.2	4.8	1.6	3.6/77*
Tutorials	5.4	1.5	5.1	1.3	ns#
Lecture notes	5.9	1.2	5.4	1.4	ns
Text book	5.0	1.7	4.7	1.6	ns
Tutorial exercises	5.8	1.1	5.1	1.3	2.7/77*
Assignment work	5.8	1.3	5.5	1.2	ns
Class mates	4.9	1.5	4.7	1.8	ns
Tutor	5.5	1.6	5.5	1.4	ns
Web site	5.8	1.2	4.7	1.4	3.7/76*
* indicates F test results significant at p <=0.05 # ns = difference not statistically significant					

Resource was not useful=1
Resource was very useful=7

3.4 Usefulness of resources

Table3 lists the means and standard deviations of the students' ratings of usefulness of resources provided for Visual Basic and COBOL. Both subjects provided similar types of teaching resources.

t-tests were used to determine any differences between the usefulness ratings between subjects. The results indicate that the Visual Basic lectures were rated significantly more useful than the COBOL lectures. From the standard deviations it can be seen that there was greater variation in the ratings of the value of lectures amongst the COBOL students. Both groups of students found the tutorials and their tutors useful however there was greater variation in the ratings amongst the Visual Basic students about this. The most frustrating finding was that both groups found their classmates the least useful resource. This is frustrating because both lecturers were trying to create collaborative learning cultures [7][11][12].

Each subject had a Web page that contained subject administration information, tutorial exercises, assignment work and access to a self-evaluation quiz of multiple choice questions [4]. The Web page for the Visual Basic subject also contained the lecture notes and a facility for students to monitor their progress in labs in comparison to other students [5]. The students found the Visual Basic Web site significantly more useful than the COBOL Web site.

A comparison of the ratings of tutorial exercises showed that Visual Basic Tutorials were seen as more useful than the COBOL exercises, and this may have been a consequence of the Visual Basic tutorial exercises having been designed to minimise poor learning tendencies within students [2] and to encourage good learning behaviours [5].

There were no significant differences between the subjects on the students' ratings of the usefulness of assignment work and lecture notes.

3.5 Difficulty of concepts

The survey questionnaire for both subjects asked students to rate the difficulty of various concepts in both the programming languages. These included things such as *variables and types*, *iteration*, *arrays* and *file access methods*. Some of these were common to the two languages so it was possible to compare student ratings. The only statistically significant difference found was for *sequential files* (t=2.021 ,df=75) where students found the concept easier in COBOL (mean of 3.7) than in Visual Basic (mean of 4.4) .

In COBOL the students found concepts progressively more difficult with the earliest topic having a mean rating of 3.9 and the others increasing up to 5.3. This pattern did not appear in the Visual Basic data. Related to this is the fact that the standard deviations for the ratings in COBOL were similar across all concepts while those for Visual Basic showed greater variation.

Table 5 Student ratings of satisfaction with subject and course

	Visual Basic		COBOL		t
	Mean	**SD**	**Mean**	**SD**	
Enjoyed the subject?	5.4	1.2	3.6	1.7	5.6/77*
Satisfied with subject?	5.0	1.1	3.9	1.2	4.6/77*
Satisfied with course?	5.1	1.3	5.0	1.0	ns#
Recommend the course?	5.1	1.4	4.2	1.8	2.4/77*

* indicates t-test results significant at p <=0.05

\# ns = difference not statistically significant

Strong disagreement=1
Strong agreement=7

3.6 Behavioural Variables

Both groups of students were confident that they would complete the year successfully (mean of 5.2), although the Visual Basic students without previous programming experience were significantly less confident. Those with previous programming experience had a mean rating of 6.33 while those without such experience had a mean of 4.55 (t=2.5 df=26).

The means and standard deviations of the students' satisfaction ratings of Visual Basic and COBOL are shown in Table 5. Both groups of students were reasonably satisfied with the course. t-tests on the results show significant differences however between their enjoyment and satisfaction of the subjects. The Visual Basic students expressed greater satisfaction with their subject and rated it as more enjoyable. More Visual Basic than COBOL students indicated that they would recommend others to do their subject. There was greater variation amongst the COBOL students about this.

The behavioural variables were also explored using multiple regression analysis because there is a broad set of evidence which indicates that some of these variables are causally related [9] [14]

All of the items measuring reactions to the subjects were regressed on confidence and satisfaction. The model for confidence in completing the year was not significant but that for satisfaction was. The main contribution for the regression came from *enjoyed the subject* and, to a lesser extent, *kept up with the work. Pace, Content* and *difficulty* did not have statistically significant contributions.

3.7 Qualitative data

Students were asked indicate what the best and worst features of learning each language were. There were many more positive statements about Visual Basic with many students commenting that Visual Basic was easy, interesting and fun. Comments from Visual Basic students included:

- *Visual Basic is easy, not too difficult.*
- *Easy to create programs, easy to use the GUI.*
- *I liked its simplicity everything seems to be done for you,*
- *you can design screens before you start programming.*
- *Visual Basic is fairly simple compared to other languages, I liked the way the program was graphically based.*
- *debugging facility is easy to use*

Fewer students were as complementary about COBOL, stating that COBOL was hard, boring, and frustrating. Visual Basic with its GUI interface, lending itself to exciting interactive applications is a hard act for COBOL to follow!

Students indicated more motivation to learn Visual Basic. Visual Basic was seen as advanced and new. Typical comments from Visual Basic students included:

- *I can learn more things in Visual Basic, and it will be easy to find a job in the future because it is widely used.*
- *Good job prospects*

In contrast, COBOL was perceived as old. A student commented:

- *I'm skeptical about its future`*

Some of the Visual Basic students expressed concerns about the speed at which the language was taught. The students commented that they had to remember a lot of things, and they lacked the skills to use the debugging facilities, the editor, and the Visual Basic environment. These are typical anxieties of novice programmers (Winslow, 1996), highlighted by the following comments from Visual Basic students:

- *The speed that it was taught, especially to students with no programming background*
- *The windows based environment kept crashing*
- *The program not loading*
- *The auto debugger*

Many of the Visual Basic students (57%) were learning programming for the first time and these problems were not mentioned by the COBOL students, most (93%) of whom had previous programming experience.

4 Discussion

An overall impression from the qualitative data is that the students were more positive about learning Visual Basic in preference to COBOL. The students preferred programming in Visual Basic and using its graphical environment.

This was reflected in the quantitative data where there were statistically significant differences favouring some aspects the ratings of Visual Basic over COBOL.

The educational reasons for some of these differences are not easy to isolate (our aim was to open up the area rather than produce a definitive study) although there are some indicators. The pedagogical model being used for Visual Basic included the use of self-formed study groups in which students voluntarily participated. This could explain some of the difference in the time being spent in Visual Basic versus COBOL where the latter was using a more conventional pedagogy.

The study groups were formed as a direct result of applying the Reciprocal Feedback [11] in the lecture series. One outcome of this feedback was that students indicated that they wanted to talk to others about the subject and their particular programming concerns. Time in the lecture was devoted to forming study groups, and students then contacted each other outside of class time to collaborate on the lab exercises, assignments and exam. The study groups may have also helped students keep up with the pace of the subject highlighted from the data in Table 3. Against this there is the fact that Visual Basic students did not rate class mates as more useful than did the COBOL students. In fact class mates had the lowest mean rating for both groups.

What is also of interest is the fact that the students in the two subjects did not differ in the level of difficulty they gave to comparable content areas, except for file handling where COBOL came out as easier.

These factors raise questions about how the different pedagogical approaches do, in fact, impact on student learning. It is assumed, for instance, that by using student oriented teaching methods, students are better able to integrate their educational experience. There are only marginal differences in student outcomes from this study in spite of differences in teaching approach.

Although more students stated in their comments that Visual Basic was easy, surprisingly when the students' ratings of individual language concepts were compared the only significant difference in difficulty was that sequential files were seen as easier in COBOL. This topic was introduced much earlier in the semester in COBOL than in Visual Basic. All the other topics that have been compared were introduced in the same order in both subjects. The students generally found the topics presented were increasingly more difficult as the semesters progressed. This pattern was more apparent in COBOL. Learning programming is a very cumulative exercise with each new topic often building on knowledge from previous topics and therefore understanding of each topic depending on the understanding of previous topics [8]. However it would be a good idea, where possible, to vary the order of presentation by interspersing easier topics with the more difficult ones. This would reduce the pressure on students who fall behind in their work and give them a chance to catch up.

Both subjects provided similar types of resources for the students in printed format, however the Visual Basic Web site had additional resources in the form of program examples, and other computer assisted tools to support self-directed learning. The lecture notes were also available online. The students saw this as a more useful resource than the COBOL Web site. Perhaps the fact that the Visual Basic students had additional reasons to access the Web site encouraged them to make more use of it and also made them aware of other resources on the site. The data does not give any conclusive picture of the impact of resources on perceived performance and it was not possible to compare actual performance (approval to do this had not been sought from the University Ethics Committee).

5 Conclusion

This study was initiated to begin the exploration of student responses to programming languages within computing degrees. As might be expected, the results were mixed. There were differences between the student experience of COBOL and of Visual Basic but these differences were not necessarily consistent given the differences in the pedagogical models used by the two lecturers. The behavioural results indicated the importance of going beyond basic educational questions if we are to understand student behaviours within an educational environment.

The finding that students found Visual Basic more enjoyable was perhaps expected, however it was interesting that their enjoyment of the subject was significantly more important tin their satisfaction with the subject than whether they felt they were coping with the work and how difficult they found it. This research has highlighted aspects of teaching first year programming that influence student satisfaction and impact on learning outcomes.

This study has raised further issues which has or will be dealt with in further research. For instance, a research project has begun on student motivation and programming language choice, and their satisfaction with the language as an educational experience. Another project is looking at the more general question of student satisfaction. But areas which clearly need more research include the question of how programming software and environments influence students' valuations of, and satisfaction with, a programming language. Over and above this, our research has once more raised the general pedagogical questions about the specific qualitative and quantitative effects of one pedagogical model over another.

References

[1] Affleck, G. & Smith, T., "Identifying a need for Web-based course support", Proceedings of 16th ASCILITE conference, Brisbane, Australia, 5-8 December, pp 1-7 (1999).
[2] Baird, R.J., & Northfield R.J., "Learning from the Peel Experience", Melbourne: The Monash University

Printing Services (1995).
[3] Carbone, A. & Golshevsky, D.,"G-SPI: A Graphical Student Progress Indicator", Proceedings of the 2nd Asia-Pacific Forum on Engineering and Technology Education, Sydney, Australia, 4-7 July (1999).
[4] Carbone, A., Schendzielorz, P. & Zakis, J.D., "A Web-Based Quiz Generator for Use in Tutorials and Assessment", Global Journal of Engineering Education, Vol. 1, No. 3, pp. 341-346 (1997).
[5] Carbone, A., Mitchell, I., Gunstone, D. & Hurst, J., "The Student Learning Experience: Characteristics of Programming Tasks that Lead to the Poor Learning Behaviours", Proceedings of HERDSA'99, Melbourne, Australia, 12-15 July (1999).
[6] Gordon, J.R., Organisational Behavior NJ:Prentice Hall 5th Edn. (1995).
[7] Hagan, D. & Sheard, J., "The value of discussion classes for teaching introductory programming", Proceedings of ACM ITiCSE Conference on Integrating Technology into Computer Science Education, Dublin, Ireland (1998).
[8] Liffick, B.W., "A novice programmer's support environment", ACM SIGCSE Bulletin, Vol. 28, No. 1, (1996).
[9] Malley, J., The Measurement and Meaning of Student Satisfaction in the VET Sector: A Review, Melbourne:ACER. (1998).
[10] Mitchell, I., Macdonald, I., Gunn, F. & Carbone, A., "Turning Computer Science Demonstrators into Teachers", Proceedings of Australasian Science Education Research Association (ASERA), Canberra (1996).
[11] Rennie, P. & Carbone A., "Putting soul back into teaching: Building social capital to enhance student learning", Proceedings , HERDSA'99, Melbourne, Australia, 12-15 July (1999).
[12] Sheard, J. & Hagan, D., "Designing and Developing a new learning environment for teaching introductory programming: change for effect.", Proceedings of World Multiconference on Systemics, Cybernetics and Informatics, Caracas, Venezuela, July (1997).
[13] Winslow, L. E., "Programming Pedagogy – A Psychological Overview", ACM SIGCSE Bulletin, Vol. 28, No. 3, (1996).
[14] Wittingslow, G. & Markham, S., "Customer-driven modelling of satisfaction Behaviour", Australasian Journal of Market Research Vol. 7, No. 2, pp29-38 (1999).

The Research on Difficulty of Asynchronous Learning Materials Based on Studying Time Distribution

Wu-Yuin Hwang and Rueng-Lueng Shiu
Information and Computer Education
National Kouhsiung Normal Univeristy
wyhwang@nknucc.nknu.edu.tw

The purpose of asynchronous distance learning systems is to enhance students' learning performance in the internet. In this paper, we investigate the characteristics of the asynchronous materials and propose the criteria to evaluate them. Employing the criteria, the materials could be adjusted to meet most students' learning pace. First, the TDC (time-distributed curve) which is a learning curve is derived from students' studying time distribution. By the TDC, it is obtained that the more difficult the materials of the chapter are the steeper the TDC becomes. Also the total learning time of each chapter indicates the quantity of the matter. Employing the total time of each chapter, we could evaluate whether the quantity of the matter is sufficient to match students' learning desire.

Keywords: **distance learning learning portfolio learning behavior learing time distribution**

1 Introcduction

1.1 The distribution of learning time with learning attitude

Teachers could interact with their students immediately at the classroom. Thus, they could get the learning behavior of their students by students' response. The learning behavior is regarded as a good measure to evaluate learning performance. But it is really hard to obtain every student's learning process and attitude because there are at least 30 students in each class. However, employing the database technology in asynchronous learning systems, it is possible to obtain all of the student's learning process and studying time.

1.2 Learning time distribution

In traditional education, students learning together in the classroom at the fixed time, and teachers control the course proceeding. But it is difficult to pay attention to all students. However, asynchronous learning systems not only provide a brand-new perspective to long-life learning but also keep track of learning time of all students. In accordance with the learning time of all students, teachers could modify the matter to match learning goals.

2 Experiment and analysis

The experimental course in our asynchronous learning system is "Basic computer concept", the materials of the course are divided into 12 chapters. The progress-control mechanism is that students need to finish the homework of the chapter in order to be promoted to the next chapter. Thirty participants engage in this experiment and they are all teachers.

The student' s learning time and login time are recorded by technologies of ASP(Active Server Page) and Database. Therefore, we could get which chapter students read and how long they read the chapter. The important curve, Time-Distributed Curve (TDC), is generated by linear regression analysis. From the slope and the area of TDC, some characteristics and results are obtained.

2.1 TDC and DCA (Degree of Course Acceptance)

Student' s reading time each chapter is recorded in our experiment. The recorded time begins from the date when the teaching materials are put in the internet for 15 days. In each chapter, all of the student' s learning time everyday is summed up.

Employing the recorded data and derived chart, each chapter has a unique TDC (time-distributed curve) by linear regression analysis. According to the time-distributed curve, teachers may decide whether the materials should be improved.

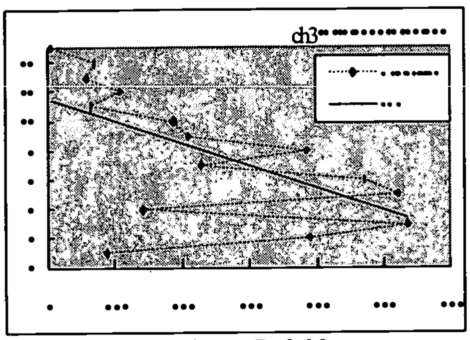


Fig.1 The TDC of ch3

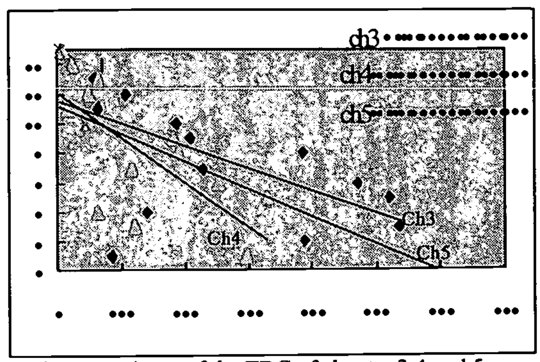


Fig.2 Comparisons of the TDC of chapter 3,4 and 5.

In Fig. 1, the X axle indicates time value and its time unit is one minute not an hour and The Y axle indicates days. For example, the total time on the 4th day is approximate 150 minutes. The slope of the TDC is minus because the total studying time would decrease while students proceed to study the matter.

The value of the slope is required to be concerned. The larger the value of the slope is, the smoother the TDC becomes. For example, figure 2 made comparisons of the TDC of chapter 3,4 and 5. Obviously, the TDC of chapter 4 has the smallest slope because it is the steepest one. And the TDC slope of chapter 3 is slightly larger than that of chapter 5. Thus, it is the most difficult to read chapter 4 and it is the easiest to read chapter 3. The reasons why the materials are hard to study may be either the materials are complicated or the user interface is not friendly to read. According to the above description, the slope of TDC could be termed as Degree of Course Acceptance (DCA, It means the harder the topic to read the smaller is the DCA.)• Besides the TDC' s slope is proposed to determine the degree of materials acceptance, there is another important characteristic, the area of the TDC, to influence the amount of learning time.

Based on the area and slope of TDC, the difficulty and quantity of the materials could be evaluated. According to the above description, it is shown that the quantity of materials would affect the amount of learner' s studying time, also the difficulty of materials would affect the length of learning period. Due to these reasons, there are two margin lines, quantity and difficulty, in Fig. 3. The two margin lines are termed e are "Margin Line Of Quantity (MLOQ)" and "Margin Line Of Difficulty (MLOD)". There are plentiful materials on the right of MLOQ, but there are poor on the left side. The upper of MLOD the materials are located the harder they are read, but lower are easy.

Since the features of MLOQ,MLOD,DCA and the area of TDC are proposed, there are four kinds of situations that the TDC represents as follow:
1. It is easy to read the material, and the contents are plentiful.
2. It is easy to read the material, but the contents are poor.
3. It is hard to read the material, but the contents are poor.
4. It is hard to read the material, and the contents are plentiful.

The MLOQ and MLOD could be employed to enhance discriminating the difficulty of the materials if the DCA and the TDC's area of the chapters are different. Finally, how is the value of the MLOQ and MLOD obtained? The MLOQ is the average of all students' learning time of one chapter. The MLOD is the average of all students' learning days of one chapter.

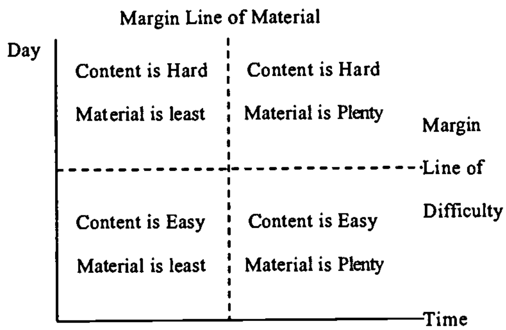


Fig.3 MLOQ and MLOD

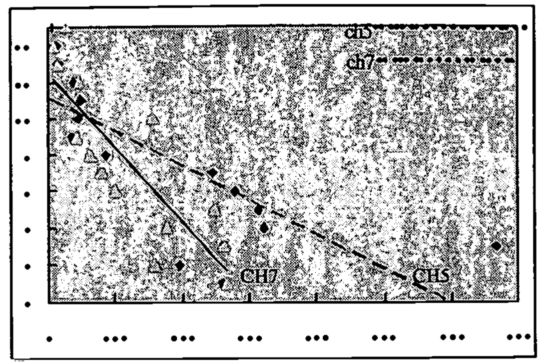


Fig.4 Compares the TDCs of the ch5 & 7

2.2 Time distribution of the interdependent course

What else may affect one' s effort in the course? There are relationships between two topics. For example, there are relationships of dependency between chapter 5(Internet I) and 7(Internet II). Generally, the topic "Internet I" is dedicated to construct the fundamental concept and "Internet II" introduces the advanced ideas and practice. According to the normal teaching policy in both topics, the "Internet I" should have fewer and simpler materials than the "Internet II". Thus learners spent much less time to study "Internet I" than "Internet II".

Fig.4 compares the TDCs of the two chapters. As shown in Fig. 4, it is easy to find out chapter 7 has a smaller DCA (the slope of TDC), that is, chapter 7 is harder than chapter 5. Furthermore, the area of chapter 7 is less than that of chapter 5. The TDC of chapter 5 is located at approximately 11 on Y axle and 600 on X axle and the TDC of chapter 7 located at 12 on Y axle and 280 on X axle. According to MLOQ and MLOD as shown in fig.3, we concluded that "The chapter 7 is more difficult than chapter 5, but its quantities are much less". It is different from we described before, "Internet I" should have fewer matters than "Internet II". In our experiment, we provided much more contents in chapter 5 than chapter 7. Therefore the amount of materials in chapter 5 should be reduced.

3 Conclusions

The asynchronous learning service is an on-line collection of hypertext that provides us a new way to learn. Their students with different native intelligence come from any place and go to learn when they would like. It is very important to design and evaluate the asynchronous teaching matters so as to match teaching goals. This paper proposed some basic criteria to investigate the characteristics of teaching matters, then gave an advise to modify them to meet the learning desire. The basic criteria, the area and slope of TDC, are derived from learning time distribution. Through the basic criteria, instructors could modify the materials in accordance with most students' learning pace and talent. Especially, our proposed mechanism is worth much attention to develop the adaptive learning system. Once the asynchronous learner' s studying portfolio is available, the materials could be real-time adjusted to match the learner' s state.

Reference

[1] • • • • • • • • • • • • • v• • • • • • • • • • v• • • • • • • • • ;pp 13-25, 67 • ;1998• •

[2] • • • • • • • • v• • • • • • • • • • • • • • • • • • v, • • • • • • • • • • • • • • • •

[3] • • • • • • • • v• • • • • • • • • WEB • • • • • • • • • • • • • • v• The 8th International Conference on Computer-Assisted Instruction• pp391-399,1998

BEST COPY AVAILABLE

Towards a model of using Information Technology in education for pre-service teacher education

Kai-ming LI, Yiu-sing LAM, Pak-hung LI and Kwok-leung WU
Department of Curriculum and Instruction,
Hong Kong Institute of Education, 10, Lo Ping Road, Tai Po, N.T. Hong Kong
kmli@ied.edu.hk, yslam@ied.edu.hk, phli@ied.edu.hk, klwu@ied.edu.hk

This paper reports the present scenario of using computer and traditional instructional media for primary class teaching in HKSAR. 323 primary teachers who have attended staff development seminars and refresher training workshops in the use of IT in education were invited to provide information for the study. The teaching time in a week and the teaching modes with 16 instructional media including computer technologies were examined. Results showed that textbook, blackboard and printed text materials remain the dominant instructional media in current practice of teaching in primary schools. The use of computer technology is rare despite the expectation that computer and computer-related technologies will make learning more effective and efficient and even to replace the traditional "educational technologies". The findings also indicated that technologies were used mostly as information delivery tools. Teaching strategies were limited to mass teaching and teacher-centered presentation. This phenomenon may have relationship with the ineffective training in the use of IT as indicated in many researches though courses in this area have been included in most teacher education programmes around the world. The last section of this paper will discuss on the contents of IT courses and to suggest a teaching model of using IT in education for pre-service teachers education programmes.

Keywords: **Methodologies, Teaching and Learning Process, Instructional Design**

1 Introduction

The Hong Kong Special Administration Region (HKSAR) government has already launched a five-year strategic plan of promoting the use of Information Technology (IT) in education aiming at enabling our students to be competitive and technological competent in the international arena since 1998 [1]. A total of about three billion dollars in capital cost and five hundred million dollars in annual recurrent cost will be used.

Computer and computer related technologies were expected to make teaching and learning more effective and efficient when it entered the classroom in 1980s [2]. Many teacher education programmes around the world have already started incorporating computer courses as basic requirement for teacher certification. In HKSAR, the previous colleges of education[1] have also started to include computers in education and computer applications courses in the Educational Technology subject which is compulsory to all the pre-service teachers in late 1980s. However, despite the provision of this training in many teacher education programmes, many researches report that the actual usage of new technologies in teaching was very limited. Teachers are not prepared to use new technology effectively in the classroom [3] [4]. Abdal-Haqq (1995) [5] even stated that "...few teachers routinely use computer-based technologies for instructional purposes" (p.1). In U.K., the HMI also commented that "new teachers make little use of Information Technology in the lessons"[6].

The purpose of this study is to find out the present scenario of the use of instructional technologies in primary

1 The previous colleges of education were amalgamated into the Hong Kong Institute of Education in 1994.

school teaching. The teaching time and the modes of using computer and traditional technologies are examined and compared. Such information will act as the base line for future investigation on the changes in teaching modes, strategies, and the use of new technologies in the 21st century classrooms. The last part of this paper will discuss on the contents and a teaching model that may be useful for preparing pre-service teachers to use computer more effectively in their future class teaching.

2 Method

2.1 Participants

The participants in this study were 323 primary teachers who attended staff development seminars and refresher training workshops in the use of IT in education offered by the Department of Curriculum and Instruction of the Hong Kong Institute of Education in 1999. 76% of them were female primary teacher. 95% of them possessed personal computers at home. 56% of them have received computer training in pre-service teacher education programme. This sample was further divided into three groups according to their teaching experiences: 27%, under 5 years; 25%, 6-10 years; 48% over 10 years.

2.2 Data Collection

The participants were asked to complete a survey at the beginning of the seminar and workshops. The first part of the survey was the demographic data of the participants while the second and third part required the participants to respond to the time spent in a week and the different modes of using 16 instructional media selected for this study respectively (see Table 1 and 2).

3 Results

3.1 The time of using instructional media in a week

Table 1 shows that board writing remains the most frequently used medium in the classroom. About 75% of the participants spend more than half of their teaching time with it. The second frequently used medium is board drawing (about 38%) while the third one is printed medium (about 30%). The table also reveals that 10 items have their using time less than half of the total teaching time in a week (item 6-11 and 13-16). It is also obvious to see that computer technologies were seldom used in class teaching at this stage. This phenomenon may be well explained by the un-readiness of computer facilities in most of the primary schools in the period of this study.

However, the figures revealed in the mean percentage of the use of traditional media in Table 1 show that about a quarter of the participants did not use any traditional instructional media and about 57% of them taught with these media less then half of the teaching time in a week. Only 17% of them used them for more than half of the teaching time in a week. This result shows that "text-book" teaching remains the dominant strategy in most primary school teaching despite those traditional instructional media have already placed in the schools as standard equipment.

Types of Media	Never Use (%)	Less than 1/4 time (%)	Between 1/4 to 1/2 time (%)	Between 1/2 to 3/4 time (%)	More than 3/4 time (%)
Traditional Media					
1. Blackboard/Whiteboard Writing	1.5	2.9	20.4	33.8	41.4
2. Blackboard/Whiteboard Drawing	2.9	28	31.5	22.6	15
3. Realia/Model	1.9	51.3	33.2	10.6	3
4. Graphics	3.3	53.1	32	9.6	2
5. Printed Material	3.6	32.4	34	18.4	11.6
6. Photo	13.1	69.3	12.8	4.5	0.3
7. Slide	71.8	23.1	4.2	0.6	0.3
8. Overhead Transparency	40.8	38.7	17	1.9	1.6
9. Audio Tape	30.8	44.8	17.4	3.5	3.5
10. Video Tape	35.5	42.8	15.8	4.9	1

11. Tape-Slide Programme	88.5	8.9	1.6	1	0
12. Learning Package	13.1	49.4	25.6	9	2.9
Computer					
13. Computer Generated Texts and Graphics	53.8	32	11.3	1.9	1
14. Computer Presentation Programme	82.8	12.7	3.2	1.3	0
15. Computer Assisted Learning Programme	86.4	9.1	3.9	0.6	0
16. Internet	94.8	2.9	1.3	0.7	0.3
Mean Percentage :	79.45	14.18	4.93	1.13	0.33

Table 1: The Percentage of Responses to Teaching Time Used with Instructional Technologies in A Week by Primary Teachers of the Study (N=323)

3.2 The modes of using instructional media

Participants who have used the instructional media were asked to respond to the types of instructional modes of how these media were used. Table 2 shows that for the first three frequently used media as identified in last paragraph, they were used mostly for teacher's presentation (82%, item1; 79.2%, item2 and 66.7%, item4). The average percentages for group learning and individual learning activities for traditional media are 16.6% and 8.2% while those for computer are 8.6% and 4.5% respectively. These figures show that teacher's presentation is still the major mode of teaching among primary teachers at the present moment.

Types of Media	Teacher's Presentation (%)	Group Learning Activity (%)	Individual Learning Activity (%)
Traditional Media			
1. Blackboard/Whiteboard Writing	82	-	-
2. Blackboard/Whiteboard Drawing	79.2	-	-
3. Realia/Model	66.4	30.6	9.5
4. Graphics	66.7	23.5	7.6
5. Printed Material	31.5	47.4	36.7
6. Photo	48	24.5	9.8
7. Slide	20.5	4.3	3.7
8. Overhead Transparency	41.3	15	6.4
9. Audio Tape	36.4	10.4	6.1
10. Video Tape	35.5	8	4
11. Tape-Slide Programme	11	3.1	1.5
12. Learning Package	40.7	32.4	13.5
Mean Percentage :	46.6	16.6	8.23
Computer			
13. Computer Generated Texts and Graphics	26.3	17.1	9.5
14. Computer Presentation Programme	9.2	7.3	3.7
15. Computer Assisted Learning Programme	7.3	5.5	3.1
16. Internet	4	4.6	1.5
Mean Percentage :	11.7	8.63	4.45

Table 2: The Percentage of Responses to Teaching Modes Used with Instructional Technologies by Primary Teachers of the Study (Respondents can select more than one mode)

3.3 Effects of difference in gender and teaching experience on the use of instructional media

Since the sampling was not randomized, normal distribution of the sample could not be assured. A non-parametric analysis using the Mann Whitney U test was then used to compare the difference of the distribution of the responses between female and male primary teachers and the three groups of teachers with different teaching experiences.

Types of Media		Gender	Never Use (%)	Less than 1/4 time (%)	Between 1/4 to 1/2 time (%)	Between 1/2 to 3/4 time (%)	More than 3/4 time (%)
3.	Realia/Model*	Female	1.3	46.4	37	11.9	3.4
		Male	4.1	67.5	21.6	5.4	1.4
4.	Graphics*	Female	3	48.1	35.1	11.7	2.2
		Male	4.2	70.4	21.1	2.8	1.4
5.	Printed Material*	Female	3	31.8	30.5	20.3	14.4
		Male	5.6	34.7	44.4	12.5	2.8
6.	Photo*	Female	11.8	66.8	15.1	5.9	0.4
		Male	17.8	76.7	5.5	0	0
7.	Slide*	Female	74.8	19.7	4.3	0.9	0.4
		Male	61.6	34.2	4.1	0	0
11.	Tape-Slide Programme*	Female	90.9	6.9	1.7	0.4	0
		Male	80.8	15.1	1.4	2.7	0
13.	Computer Generated Texts and Graphics*	Female	58.7	30.6	8.1	1.3	1.3
		Male	37	37	21.9	4.1	0
14.	Computer Presentation Programme*	Female	89.8	7.7	2.1	0.4	0
		Male	60.3	28.8	6.8	4.1	0
15.	Computer Assisted Learning Programme*	Female	91.5	6.4	1.7	0.4	0
		Male	69.4	18.1	11.1	1.4	0

** Statistically Significant Difference at α = 0.05, Mann-Whitney U Test*

Table 3: The Percentage of Responses to Teaching Time Used with Instructional Technologies in A Week by Female and Male Primary Teachers of the Study

Significant differences were found in the distributions of 9 items between female and male teachers. In Table 3, referring to the "never use" column, it is interesting to see that female teachers used simple and traditional media (item 3,4,5 and 6) more than male teachers while male teachers used more complicated traditional media (item 7 and 11) and computer technologies (item 13,14 and 15) in this study. Similar analysis was conducted among the teachers with different teaching experiences. Only one item was found to be statistically different between the less experienced and more experienced teachers. Table 4 shows that experienced teachers used slide more than the less experienced teachers.

Types of Media		Teaching Experience	Never Use (%)	Less than 1/4 time (%)	Between 1/4 to 1/2 time (%)	Between 1/2 to 3/4 time (%)	More than 3/4 time (%)
7.	Slide*	Group A	82.4	14.1	3.5	0	0
	•	Group B	66	29.1	4.3	0.7	0

** Statistically Significant Difference at α = 0.05, Mann-Whitney U Test*

Group A: Teaching experience less than 5 years; Group B: Teaching Experience greater than 10 yearS

Table 4: The Percentage of Responses to Teaching Time Used with Instructional Technologies in A Week Between Two Groups of Primary Teachers with Different Teaching Experience of the Study

Analysis on the teaching modes of using these instructional media, however, showed that no significant differences were found between the female and male teachers and also among the three groups of teachers with different teaching experiences.

4 Discussion

From the above findings, it is obvious that the use of instructional media including computer technologies was limited. The teaching strategies employed by most primary teachers were still very teacher-centered although they have already completed instructional technology and related courses in the teacher education programme. Computer uses were rare even though more than 50 % of the participants have attended computer courses while receiving their pre-service teacher training and 95% of them possess home computers. It is evident that future teaching is influenced by the learning experiences that pre-service teachers gained in their tertiary education [7]. Researches also show that the provision of instructional models for classroom implementations of technology is far more important than the training of the "know-how" skills [8]. The instructional strategy should act as the model and should be student-centred rather than terminology and hardware centred [9]. Task-based or problem based activities are more effective than skill drilling of certain hardware or computer software by direct demonstration. A course with well–designed contents and effective teaching model for the use of IT in education is believed to have positive influence on the actual implementation in school teaching.

4.1 The Contents

We suggest that for an IT in education course to be successful, the following areas should be included. We believe that such contents allow our pre-service teachers to have more comprehensive mastery of knowledge and skills of using IT in education and enable them to put theories and practical skills into real practice in primary school teaching.

1. Understanding the development, trends, advantages and limitations of using IT in education.
2. Understanding the roles and contributions of IT and teachers in the communication and learning process.
3. Designing and producing instructional materials with IT.
4. Operating computer hardware and application software while producing and using computerized instructional materials
5. Selecting and deriving learning activities with computerized instructional materials and resources
6. Evaluating the effectiveness of computerized instructional materials and programmes that involves the use of IT.

4.2 The Teaching model

Figure 1 is a proposed teaching model of using IT in education for teacher preparation programme. This model is informed by constructivist views of learning in which the learner is the center and the actor of learning. There are six major components in the model:

1. The teacher – is the one who build this model, creates a constructivist learning environment, acts as the resource, guide and the facilitator of the learning process and models the actual implementations and strategies of using IT in an authentic context.
2. The learner – is the master of this model, comes with different background and learning style, interacts with other components of this model and to construct the knowledge and skills actively.
3. Resources and support – assist the learner to complete his/her task throughout the learning process.
4. Integration – is the experience that the learner gains when applying IT in teaching and learning in an authentic situation.
5. Reflection – is the introspective thinking allowing the learner to have deeper understanding of the IT applications and be able to examine related issues critically.
6. Monitoring strategies – provide clear instructions and directions allowing the learner to have a complete picture of the objectives and significances of the learning, the tasks to be completed and the access to relevant resources and support.

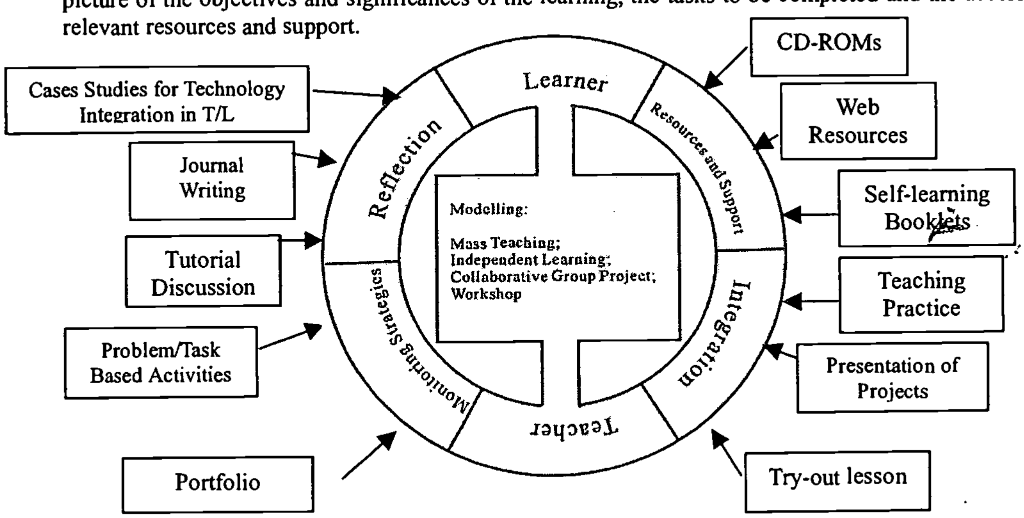


Figure 1: A teaching model of using IT in education for teacher education

5 Conclusion

The components of the teaching model guide the development of various strategies, learning activities and resources that can be found in Figure 1. Evaluation of the effectiveness of this model has been started and the results will be reported in due course. The findings of the survey in the first part of this study signal the ineffective use of instructional media both in terms of teaching time and strategies in primary school teaching. Change is expected if our students are to be really benefited by the five-year strategy of using IT in education. Teacher education, therefore, places an important role in this aspect.

References

[1] Education Manpower Bureau (1998). Information Technology for learning in a new era: 5-year strategy 1998/99 to 2002/03, November 1998, HKSAR.

[2] Goodlad, J.I. (1984). *A place called School.* New York: McGraw Hill.

[3] Bosch, K.A. and Cardinale, L. (1993). Preservice teachers' perceptions of computer use during a field experience. *Journal of computing in Teacher Education*, 10(1), 23-27.

[4] Office of Technology Assessment (OTA)(1995) Teachers and Technology: Making the Connection. US: OTA 1995 Report.

[5] Abdal-Haqq, I., "Infusing technology into pre-service teacher education", ERIC digest. (ERIC Document Reproduction Service #ED 389699). (1995)

[6] Her Majesty's Inspectors (1993). *The new teacher*. London: HMSO.

[7] Adams, P.E. and Krockover, G.H. (1997), Beginning science teacher cognition and its origins in the pre service secondary science teacher program. *Journal of Research in Science Teaching*, 34, 633-653.

[8] Novak, D. and Knowles, J. (1991). Beginning elementary teachers' use of computers in classroom instruction. *Action in Teacher Education*. 8(2), 43-51.

[9] Bigum, C. (1990). Situated computing in pre-service computer education. In A. McDougall and C. Dowling (Eds.). *Computers in Education*. North Holland: Elsevier Science.

TWO TYPES OF VIRTUAL SCHOOL IN INET SUPPORTED BY TEACHER'S GROUP—COLLABORATION TYPE AND LOOSELY CONNECTED TYPE

Shoichi Kinosita* and Nobuyuki Arakawa**
*SEITOKU University, *550, Iwase, Matsudo, Chiba, Japan 271-8555,*
E-mail: kino@po.jah.ne.jp
**Kamishinmei Elementary School, *Futaba-4, Shinagawa-ku, Tokyo, Japan*
Email: arakawa.nobuyuki@nifty.ne.jp

1 Introduction

We construct a virtual school in INET since December 1997 about elementary and secondary education. This virtual school is collaboration type. About 10 teachers are the managers who control the open and close to the courses. This members also join to "Project Group for Learning Process" founded at 1984 in Matsushita Audio-Visual Research Foundation. The courses are consists of Japanese Language, Mathematics, Social Science, Natural Science, Arts, etc. The writer of each course is voluntary and often invited by the manager. The system of this school is controlled by CGI program that counts and classify the visitors.

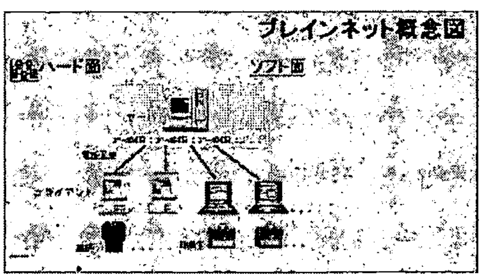


fig. 1 Structure of Type [A]

The other type -Loosely connected- virtual school will be appeared in several months. This type is the mirror image of writer's daily lesson. The writer is also the teacher at a classroom and the course is the same contents as the lesson at the class. The first purpose of this type is the help for absent student at lesson with inevitable reason.

The second purpose is the teacher's skill up the teaching methods and fill up his contents. Each course is gazed by the other writer and visitor by critical viewpoints and comments may send to him by E-mail or another way. These comments will effective for the writers. The writers are loosely connected by browsing and criticize for each other.

2 Comparison of Two Types of Virtual School

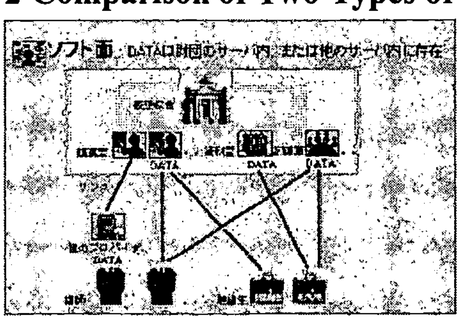


fig. 2 Software Structure of Type [A]

Let's call collaboration one is the type [A] and a loosely connected one is the type [B]. Type [A] may have fine course by fine teacher by the reason of solid watch and control and severe criticism. But the number of writers may be limited because of difficulties to make fine or excellent course. In fact, the number of writers of our school is about 20 teachers today. The increase of number of writers is very slow.

Type [B] may readily have many teachers because the reporting of own daily lesson wants little efforts except for some reviews and writing time.
On the other hand, the quality of course may not be

expected, and the learners to be supposed are very restricted.

Results

The two types [A] & [B] will be exist parallel to each other and exchange the writer, or perhaps invite the writer for type [B] at first and next to type [A] if the course will fine and universal.

The Language of both types is Japanese and every learner or visitor needs to read Japanese Language. This is an issue that is easily overcome by some Japanese to English interpretation software. Our two schools slightly gather the writers who want to spread their unique lesson and the effect appeared in the mutual discussion about order in lesson, resources, tools, and illustrations in both type.

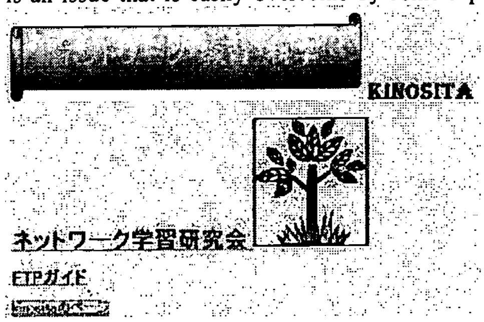


fig. 3 Front Page of Type [B]

There are many virtual schools in Japan and all over the world. These are almost supported by ministry of education, nation, or company who have many staffs working with development and editing. Our tiny two virtual schools will combine the teacher's skill and fine lessons from voluntary teachers in Japan or other country and serve the chances to learn for many learners who can't go to the school with willingness to learn.

References

[1] Our type [A] Home Page, http://www.mef.or.jp/bnm/(accessed on July 20,2000)
[2] Our type [B] Home Page, http://www.kinosita.itabashi.tokyo.jp/(accessed on July 20,2000)

Using Virtual Environments for Studying Water Phases and Phase Transitions

Jorge F. Trindade* and Carlos Fiolhais **
**Physics Department and High Education School for Technology and Management, Polytechnic Institute of Guarda, 6300 Guarda, Portugal*
E-mail: jtrindade@ipg.pt
*** Physics Department and Center for Computational Physics, University of Coimbra, 3000 Coimbra,Portugal*
E-mail: tcarlos@hydra.ci.uc.pt

In recent years, many studies have dealt with students' reasoning in science. Those studies suggested that pupils, in different degrees, have difficulties in understanding matter phases and phase transitions. To increase pupils understanding of phases and phase transitions, we are developing the "Virtual Water" project, a virtual environment centered on the learning of the structure and properties of water in its different phases. Within this environment, the molecular dynamics in the solid, liquid and gaseous phases of water and the corresponding phase transitions take place in three-dimensional space, with the possibility of haptic interaction with the molecules.

Keywords: **Virtual reality, virtual environment, water, phases and phase transitions**

1 Introduction

All substances undergo dramatic changes in their qualitative properties when certain parameters pass through particular values. Matter phases and phase transitions have received considerable attention in the framework of research on children's understandings in different ages and development stages [1-4], [10], [15].

Ice melting is an everyday example of a phase transition. When the temperature increases, keeping the pressure constant, the molecular vibrations become gradually more violent and thermal expansion occurs. Since this increase of vibration amplitude is gradual, one might expect that the macroscopic properties of water would also undergo a smooth change. While this is true for most temperatures, there is a well-defined temperature for which something dramatic happens: a sudden change in the properties of the substance and the appearance of a liquid. The liquid, in its turn and at a higher temperature, undergoes another phase transition going into a gas.

Few pupils use the corpuscular theoretical model taught in school to explain these processes. Indeed, their knowledge and understanding of the corpuscular theory of matter is sometimes very fragmentary. They apply it in some situations but not in others. For example, they may apply the corpuscular theory to explain gases but not to explain solids and liquids. There are also cases where pupils say that the shape and size of molecules changes when the state of matter changes: the shape of molecules depends on the shape of the vessel, molecules of solids are the biggest while gas molecules are the smallest for Portuguese children (13-15 years) [9], etc.

Other studies of students' conceptualization of phase transition from liquid or solid to gas have indicated that some children have difficulties conceiving gas as a substance [6] [12]. As students do not develop the general idea of gas prior to formal learning, the perceptual clues for detecting and identifying gases are weaker than for liquids and solids. Although pupils know some properties of air, they do not compare air with other gases, claiming that other gases do not have the same properties as air. A frequent explanation is that air is a big bulk system [11]. Gases are frequently linked by some invisible entity, something immaterial, for example energy in various forms. Kircher [5] also reports that high school pupils understand gases as a continuous substance with no empty space between particles.

Since the use of images is a powerful tool for understanding complex and/or abstract information and since immersion in virtual environments is a recent technique which needs to be explored and evaluated, a virtual environment for studying phases and phases transitions is being developed by the Physics and Mathematics Departments of the University of Coimbra, Portugal, the Exploratory "Henry the Navigator", in Coimbra, and the High School for Technology and Management of the Polytechnic Institute of Guarda. We have named it "Virtual Water".

2 Overview of the Molecular Dynamics Virtual Environment

"Virtual Water" (VW) is a set of virtual environments designed to help in the instruction of high school students of Physics and Chemistry (it might also be useful for freshman university students). The main goals of this virtual reality application are:

a) To provide an educational environment for students to explore some microscopic concepts which they are taught in class.

b) To develop a practical knowledge concerning the application of virtual reality techniques to education, contributing with data on the usefulness of virtual reality [13-14].

The molecular dynamics component of VW is devoted to understanding some water properties and studying its phases and phase transitions by computer simulation. These simulations are based on the corpuscular theory of matter and use the equations of Newtonian Mechanics. We assume that the dynamics can be treated classically because more realistic simulations (incorporating quantum effects) are cumbersome and more computationally demanding. We also assume that the force between any pair of molecules depends only on the distance between them.

The interactions using *dataglove* allow the user to act and change the environment in order to distinguish the properties of solids, liquids and gases. The *cybertouch* system associated to the dataglove enables the user to experience some molecular behaviors that are impossible to feel in real world. For example, in the solid phase the user may fly through the ice structure and learn about it (Figure 1). Using the *dataglove* the user is able to break the ice and with the *cybertouch* system he can feel the increase of molecular vibrations with the temperature. While breaking ice may be a common macroscopic experience, watching the network of hydrogen bond and feeling molecular vibrations, for example, are quite uncommon experiences. On the other hand, in the liquid and gas phases, it is possible see and try to grab a molecule, understanding by direct experience that its speed is bigger than in the solid phase.

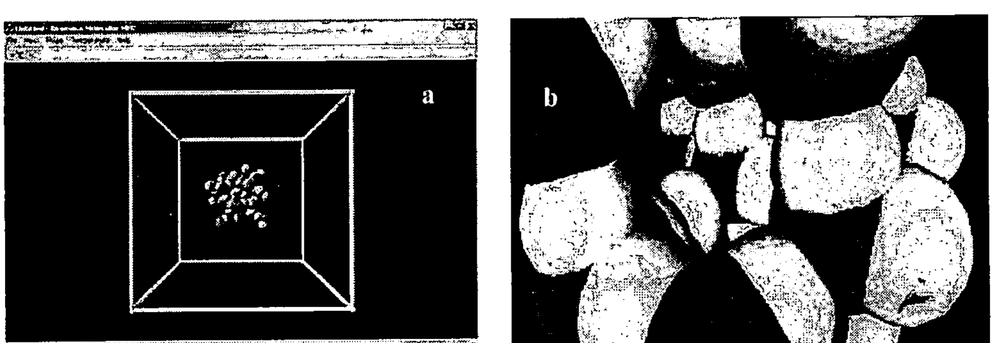


Figure 1: Two frames from the water solid phase (ice) of our molecular dynamics environment: a) balls model of a group of molecules; b) flying through the ice structure.

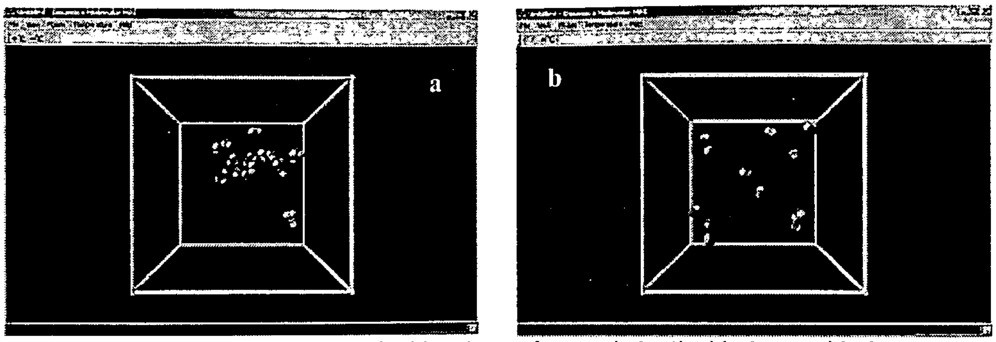


Figure 2: Frames from the water liquid and gas phases: a) the liquid phase, with the balls model of twelve molecules; b) The gas phase, showing the same molecules. These pictures, as well as those of Figure 1, were created with *PC Gamess*, *Molden*, *3D Studio Max*, being the dynamics implemented in *Visual* C^{++}on *WorldToolkit*.

Using balls models of water molecules the user may interiorize the corpuscular theory of matter. Since the molecular dynamics simulation takes place in a box (closed system) it is easy to understand that the molecules are the same in solid, liquid or gas phases. It is clear from our virtual environment that, in any phase of water, empty intermolecular spaces are present, these being smaller in the solid and liquid phases than in the gas phase (Figure 2). The density is different in the three phases.

For designing the VW models we used the free software *PC Gamess* [8], that performs the calculations on the water molecule, and *Molden* [7], for the molecular representations. For model development and optimization we used commercial software packages (*Mathcad* and *3D Studio Max*) and *Visual* C^{++} for implementing the molecular dynamics algorithm. Concerning the definition and creation of the virtual scenarios we used *WorldToolkit* (from Sense8). For navigating in the virtual environment and interacting with our models we use a *dataglove* with *cybertouch* system (for haptic information) from Virtual Technologies.

3 Conclusions

Important strategies in teaching Physics and Chemistry are based on central the idea that matter consists of particles but the fact that these are invisible hinders sometimes the development by students of the right scientific concepts. However, the analysis and comparison of various results in the pedagogic literature show that some incorrect concepts and their relationships are simply transferred from the macroworld to the micro world. In fact, there is a firm link between the concepts on matter structure and empirical knowledge of macroscopic phenomena.

If students accept the corpuscular theory mainly for gases and not for solids and liquids, it is advisable to confront them with this contradiction and to treat specifically the processes of phase changes from gas to liquid, and *vice versa*, in terms of identity of substance, identity of particles and conservation of the number of particles. Similar procedure applies to students who accept better the corpuscular theory for solids.

The use of immersive virtual environments and haptic information, although recent, seems to be a powerful means for visualizing and understanding complex and/or abstract information. Actions like grabbing a molecule, breaking hydrogen bonds networks, feeling molecular vibrations, flying through channels in ice and through the empty spaces of molecules in liquid and gas phases (as in George Gamow's book "Adventures of Mr. Tompkins"), etc. are impossible in real world but possible in computer simulations.

"Virtual Water", our virtual environment for studying phases and phase transitions based on corpuscular theory of matter is promising to make progresses along the indicated directions. We are acquiring new means in learning and teaching the Physics and Chemistry of water and building knowledge on virtual reality techniques and tools, which can later be applied to other problems. In particular, our experiment with virtual reality should point out what are the most effective educational benefits and also to indicate the weaknesses of this new technology in an educational setting.

Feedback from pupils is being collected and analyzed in order to quantify the pedagogical usefulness of our virtual environment. Of course, if these techniques prove to be successful, teacher's strategies should incorporate them. We hope that, with tools like the one we are developing, intangible experiments become more and more concrete and that this fact may facilitate the development of scientific models among science students.

Acknowledgements

The authors thank Prof. Dr. Victor Gil, from the Chemistry Department of the University of Coimbra, for his precious suggestions, and Prof. Dr. José Carlos Teixeira, from the Computer Graphics Center of the same University, for his technical advice. We also wish to acknowledge the assistance of the students Nuno Pereira and Eduardo Coutinho, who have developed the molecular dynamics component of "Virtual Water". This research was supported in part by the Portuguese Foundation for Science and Technology (project PRAXIS/FIS/14188/1998).

References

[1] Andersson, *B.*, "Pupils' conceptions of matter and its transformations (age 12-16)", Studies in Science Education, *18*, pp. 53-85 (1990).
[2] Driver, R. Squires, A., Rushworth, P. & Wood-Robinson, V., "Making Sense of Secondary Science - Research into Children's Ideas" (London: Routledge) (1994).
[3] Driver, R., Goesne, E. & Tiberghien, A. (ed.), "Children's Ideas in Science" (Milton Keynes: Open Universitv Press) (1985).
[4] Garnett, P., & Hackling, M., "Student's alternative conceptions in chemistry: a review of research and implications for teaching and learning", Studies in Science Education, 25, pp. 69-95 (1995).
[5] Kircher, E., "Research in the classroom about the particle nature of matter" in W. Jung, H. Pfundt and C. Rhoneck (ed.), in *Proceedings of the International Workshop on Problems Concerning Students' Representation of Physics and Chemistry Knowledge* (Ludwigsburg: Pedagogische Hochschule), 342-359 (1981).
[6] Lee, O., Eichinger, D. C., Andersson, C. W., Berkheimer, G. D. & Blakresle, T. D., "Changing middle school students' conceptions of matter and molecules", Journal of Research in Science Teaching, 30 (3), pp.249-270 (1993).
[7] Molden, a package for displaying MOLecular DENsity, written by G. Schaftenaar, CAOS/CAM Center Nijmegen, Toernooiveld, Nijmegen, The Netherlands.
[8] PC Gamess, a program for ab initio quantum chemistry, written by Alex. A. Granovski, Moscow State University.
[9] Pereira, M. P. & Pestana, M. E., "Pupils' representations of models of water", International Journal of Science Education, 13(3), pp.313-319 (1991).
[10] Pfundt, H. & Duit, R., "Bibliography: Student's Alternative Frameworks and Science Education", 4th ed. (Keil, Germany: Institute for Science Education) (1984).
[11] Sere, M. G., "Children's conceptions of the gaseous state prior to teaching", European Journal of Science Education, 8(4), pp.413-425 (1988).
[12] Stavy, R., "Children's conceptions of gases", International Journal of Science Education, 10(5), pp.553-560 (1988).
[13] Trindade, J., Fiolhais, C. & Gil, V., "Virtual Water, an application of virtual environments as an education tool for physics and chemistry". In *Advanced Research in Computers and Communication in Education*, Proceedings of ICCE'99 – 7th International Conference on Computers in Education, Chiba, Japan, ed. G. Cumming, T. Okamoto, and L. Gomez, vol. 2, pg. 655-658, (IOS Press, Amsterdam) (1999).
[14] Trindade, J., Fiolhais, C., Gil, V. & Teixeira, J. C., "Virtual environment of water molecules for learning and teaching science", Computer Graphics Topics, 5 (11), pp.12-15 (1999).
[15] Wandersee, J. H., Mintzes, J. J. & Novak, J. D., "Research on alternative conceptions in science". In D. Gabel (ed.), *Handbook of Research on Science Teaching and Learning* (New York: Macmillan), pp.177-210 (1994).

Web-Based Subject-Oriented Learning Program on Geophysics For Senior High School

Rong-Kuan Yang* Yi-Ben Tsai and Shi-Jen Lin*****
** Department of Earth Sciences, National Central University, Chung-li, Taiwan,*
e-mail: rk@eqm.gep.ncu.edu.tw
*** Department of Earth Sciences, National Central University, Chung-li, Taiwan,*
E-mail: ybtsai@eqm.gep.ncu.edu.tw
**** Department of Management Information System, National Central University, Taiwan*
E-mail: sjlin@mgt.ncu.edu.tw

Homepages of contents on the topics of Earthquake, Plate Tectonics Theory and Chi-Chi Earthquake in the field of Geophysics have been composed for the subject-oriented learning program for senior high school students. Learning test activities were performed to testify the teaching and learning effect via Internet. The homepage contents bear the characteristics of (1) scientific theory-based descriptions, (2) more local examples, (3) highly relating to common life, (4) more dynamic illustrations, and (5) providing interesting practicing works. The results of subject- oriented learning test activities in this study show that the learning style, learning procedures and the homepage contents are all highly accepted by the participants from senior high school. And the learning effect is obvious as judged by comparing the pre-learning and the after-learning concept diagrams drawn by each individual participant.

Keywords: **subject-oriented learning program, learning test activities, concept diagrams**

1 Introduction

Internet system supplies plenty of knowledge conveniently and quickly, the explorer can achieve the purpose of self-learning by collecting, reading, analyzing and combining different kinds of data via Internet. For the purposes of improving the learning environment, enhancing the teaching quality, and raising the learning effect on Earth Sciences education for senior high school, web-based course contents on topics of Earthquake, Plate Tectonics Theory and Chi-Chi Earthquake in the field of Geophysics have been set up based on the idea of subject-oriented learning program [2]. Senior high school students can not only do the self-learning but also exchange their learning ideas with others through Internet learning system under different conditions of time periods and places. By joining the study results from fields of education, computer technology, geophysics and geology, subject-oriented learning test activities for each specific subject were performed respectively with the participation of volunteered teachers and students from different senior high schools so as to evaluate the learning effect of Internet learning system.

2 Objectives

By especially considering the educational idea of subject-oriented joint learning mode[1], homepage contents were set up. Internet learning test activities were performed by using joint learning software and concept diagram drawing software developed by the computer technologist' s [3]. The major objectives of the study are as follows:

1) Setting up basic web-based contents on Earth Sciences so as to enhance the teaching and learning interests for high school education, the contents may also serve to a better understanding of the earth environment for social people.

2) Setting up the effective searching catalog so as to assist in surveying and collecting related data.
3) Assisting in solving educational problems and improving learning effect through Internet communication system.

3 Subject-Oriented Joint Learning Test Activity

Subject-oriented learning strategy was the major concern in the study. Participants were advised to carry out the learning program by reviewing and collecting related contents through Internet. All the communications were put through BBS posts or e-mails, there were volunteer helpers, college students, to respond all proposed questions from time to time. Team works were important besides individual learning as well, each would share personal learning results with others and came out a group report, individual learning effect was evaluated by comparing the pre-learning and after-learning concept diagrams.

After entering the web site "gepedu.gep.ncu.edu.tw" (Fig. 1), participants would click the right icon to choose the specified subject for the activity. Each one should draw a pre-learning concept diagram by connecting the provided concept terms with proper words after watching the "Miss story" (a short documentary film) prepared for the subject. And then, the major stages for the learning test activity were:

1) Participants were separated into groups of different topics on the specified subject based on his own study interest.
2) Every group set up its study assumptions and strategy; certain assignments were distributed to each individual member of the group.
3) Group members started to survey and collect related data for the topic, and all the working records were kept by using joint learning software.
4) Participants bearing the original role of topic group were re-divided into different groups of experts to cover more study fields. Members discussed and shared personal study ideas and results with others.
5) Each participant returned to his original group of topic and made after-learning concept diagram a group report for the study was also made with the efforts of all the group members.

4 Results and Discussions

Three learning test activities were finished in the study [2]; detailed descriptions of the activities are in Tables 1 to 3. When first learning test activity on Earthquake was being held; related software was not well developed. Internet function was limited to content reviewing. By the time of second learning test activity on Plate Tectonics Theory software was more fully developed, all works were done under Internet environment; more working records were preserved in personal joint learning files for the second and the third activities. All discussions and questions among the students were put through BBS posts and e-mails; volunteer helpers joined the discussions and also answered the questions in time. There are 119 posts from the second activity and 552 posts from the third activity, most of the posts are highly related to the learning program. Each participant finished drawing two concept diagrams in pre-learning and after-learning stages respectively, there are 24 diagrams from the second activity and 46 diagrams from the second activity. And each group had also submitted the group report as required in the learning activity in time, there are 2 and 3 reports for the first and the second activities respectively. Plenty of discussions and notes have also been recorded in the joint learning software in Internet. However, the insufficiency of the Internet system and the learning pressure under traditional education system may interrupt the continuous progressing of the learning program, occasional oral communications seem to be necessary. Though the ability in data analyzing, reducing and deducing may not be well satisfied, students show obvious improvement in the knowledge of the subject as judged by comparing and analyzing the individual pre-learning and after-learning concept diagrams and from group reports.

5 Conclusion

Homepage contents for all the three subjects are highly acceptable to high school students and teachers, most of them confirm with the learning effect of the subject-oriented joint learning program. If the traditional learning pressure would be suitably released, students will be more willing and free to perform self-learning program through Internet learning system even though they are not very well familiar with the operation of the used software.

References

[1] Chen, F. C., "The study of a cooperative project-based learning design in network-based environment", NSC Study Report, NSC-88-2511-S-008-002, pp. 1-8(1999)

[2] Chin B. H., Yang, R. K. and Wang, C. Y., "Development of a learning environment for solid earth (geophysics) through Internet", NSC Study Report, NSC-88-2511-S-008-005, pp. 1-5(1999)

[3] Lin, S. J., Chou, S. C., Chen, Y. M., Chan, T. W., "A study of Internet-based collaborative project learning environment", NSC Study Report, NSC-88-2511-S-008-003, pp. 1-8(1999)

Table 1 Learning Test Activity on Earthquake

Time	1998.5.3, 1 day
Location	computer room in Wuling Senior High School
Participants	12 high school students, 3 high school teachers, 17 volunteer helpers(students and teachers from Department of Earth Sciences, National Central University)
Subject	Earthquake
Group of Topic	Occurrence and Distribution, Intensity and Magnitude
Working Pattern	content reading via internet, one to one oral communication, working processes recorded by volunteer helpers
Evaluation Materials	concept diagram, questionnaires, working records

Table 2 Learning Test Activity on Plate Tectonics Theory

Time	1999.2.27~1999.3.6, 8 days
Location	computer rooms in Wuling Senior High School, ChenSheng High School and National Central University, personal working environments
Participants	6 students and 1 teacher from ChenSheng High School, 6 students and 1 teacher from Wuing Senior High School, 7 volunteer helpers from National Central University
Subject	Plate Tectonics Theory
Group of Topic	Continental Drift, Sea Floor Spreading
Group of Expert	Dynamics, Mechanism, Effect
Working Pattern	Besides software learning on the first day and evaluation meeting on the last day, all the other works were all carried out via Internet.
Evaluation Materials	pre-learning and after-learning concept diagrams, questionnaires, BBS posts, working records in joint learning software, three assignments

Table 3 Learning Test Activity on Chi-Chi Earthquake

Time	2000.2.2~2000.2.26, 25days
Location	computer room in National Central University, personal working environments
Participants	4 students and 1 teacher from ChenSheng High School, 2 students and 1 teacher from TaoYuan High School, 2 students and 1 teacher from Wuling Senior High School, 3 students and 1 teacher from HsinChu Experimental High School, 2 students from ChungLi High School, 5 students from HsinChu High School, 2 students from HsinChu Girls' High School, 2 students from ChenDer High School, 1 students from ChuTung High School, 7 volunteer helpers from National Central University
Subject	Chi-Chi Earthquake
Group of Topic	Mechanism, Analysis, Effect
Group of Expert	Focus, Magnitude, Focal Mechanism, Hazard
Working Pattern	Besides software learning on the first day and evaluation meeting on the last day, all the other works were all carried out via Internet.
Evaluation Materials	pre-learning and after-learning concept diagrams, questionnaires, BBS posts, working records in joint learning software

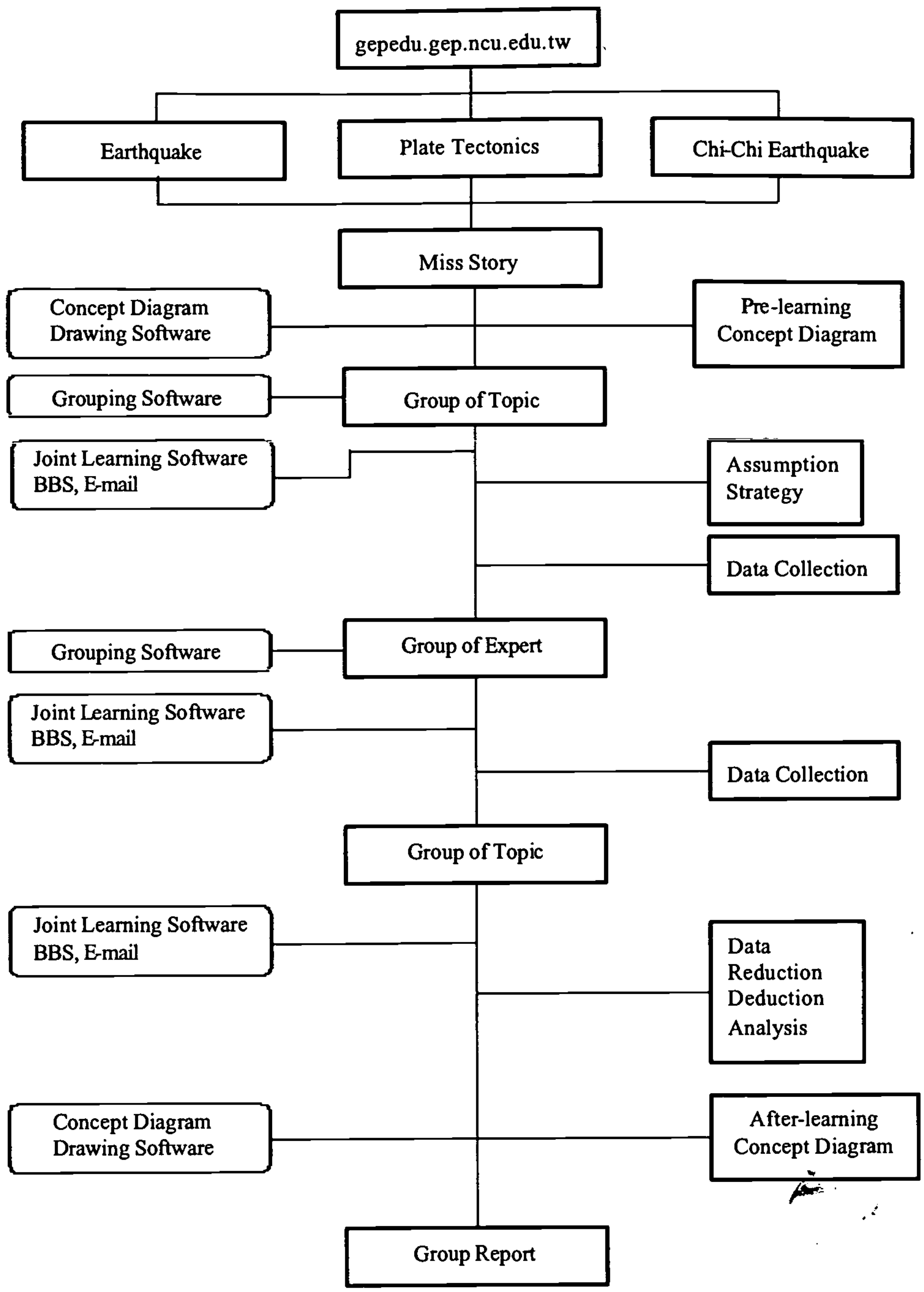


Figure 1 Flowchart for subject-based joint learning test activity

NOTICE

REPRODUCTION BASIS

☒ This document is covered by a signed "Reproduction Release (Blanket) form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☐ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").

EFF-089 (9/97)