DOCUMENT RESUME

ED 454 825 IR 020 804

TITLE	ICCE/ICCAI 2000 Full & Short Papers (Instructional Design).
PUB DATE	2000-11-00
NOTE	90p.; 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/PC04 Plus Postage.
DESCRIPTORS	*Computer Uses in Education; Constructivism (Learning); *Educational Technology; Elementary Secondary Education; Information Technology; *Instructional Design; Internet; Postsecondary Education; Teacher Education
IDENTIFIERS	Web Based Instruction

ABSTRACT

This document contains the full text of the following full and short papers on instructional design from ICCE/ICCAI 2000 (International Conference on Computers in Education/International Conference on Computer-Assisted Instruction): (1) "An Experiment of Situated Learning on College Students" (Fonchu Kuo and others); (2) "An Approach to Modeling an Educational Domain" (Gennadiy Atanov); (3) "Design and Implementation of Teaching Models in Web-Based Teacher Training" (See-Min Kim and others); (4) "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 and Genevieve Legare); (5) "Is Everyone on Board: Learning Styles and the Internet" (Michelle Hsiang and others); (6)"Learning Digital Logic by Concept Mapping" (Hsiu-Mei Lin); (7) "Online Education: A Learner-Centered Model with Constructivism" (Kam Hou Vat); (8) "Schema Theory-Based Instructional Design of Asynchronous Web-Based Language Courses" (C. Candace Chou); (9) "Student Learning Issues: Factors To Consider Prior to Designing Computer-Assisted Learning for Higher Education" (Paul Wilson and George Coghill); (10) "Students' Attitude toward WPSS in Supporting Classroom Learning" (Hsiu-Ping Yueh); (11) "The Application of Scaffolding Theory on the Elemental School Acid--Basic Chemistry Web" (Zangyuan Own, Kai-Pein Wong); (12) "The Development of a Multimedia Program for Teachers To Integrate Computers into the English Curriculum" (Ya-Fung Chang); (13) "The Impact of Learning Style on Group Cooperative Learning" (Fang-Yi Hu and Nian-Shing Chen); (14) "The Production of Web-Based Interactive Video from Structured Scrip" (Cheng-Huang Yen); and (15) "Towards a Model of Using Information Technology in Education for Pre-Service Teacher Education" (Kai-Ming Li and others). An abstract of the following paper is also included: "Making the Most of the Internet for Potential for Education" (John Wang and Dilek Sanver). (MES)

ICCE/ICCAI 2000 Full & Short Papers (Instructional Design)

Proceedings

Content

►Full & Short Papers (Instructional Design)

▲HOME

An experiment of situated learning on college students

Fonchu Kuo*, Hin-chung Wong, Gin-Fon N. Ju***, P.M. Chen*, T.W. Lin*, Shu-Hui Liu** and Hsiao-Chiao Hung****

**Department of Computer Science, Soochow University, Taipei, Taiwan, R.O.C., P. O. Box 14-135, Taipei, Taiwan*

E-mail: kfc@cis.scu.edu.tw

***Department of Microbiology, Soochow University, Taipei, Taiwan, R.O.C. No. 70, Lin-shi Road, Shi-lin Area, Taipei, Taiwan*

wonghc@mail.scu.edu.tw

****Department of Psychology, Soochow University, Taipei, Taiwan, R.O.C., No. 70,Lin-shi Road, Shi-lin Area, Taipei, Taiwan*

gju@cis.scu.edu.tw

Several experiments of situated instruction have been done in elementary school. We conduct the inaugural experiment on college students. A group of 44 students who are taking food microbiology course involved in this experiment. We designed a science fiction named "Save the Taiwan", which is a story regarding a Microbiology technician handles a disease crisis. A student can learn how to deal with the crisis and solve the problem of an infectious disease when he uses this CAI software. The evaluation practice consists of four dimensions, subject domain demands, instructional demand, user interface demand, and pragmatic demands. The result of evaluation shows notable effect on college students.

Keywords: **situated learning, evaluation of CAI, Microbiology**

1 Introduction

The advantage of traditional instruction is that the knowledge that students learned can be "stiff knowledge". The stiff knowledge can not be smoothly applied to solve the actual problem in a real environment (Brown, 1989). Situated cognition bases on the theory that the learning should be constructed at real situation. Only when the learner derive the knowledge from the real situation then he realizes the real meaning of the learned knowledge and cherish the value of knowledge and take it as the tool for solving the problem. (Cognition and Technology Group at Vanderbilt, 1990)

There was experiment on elementary school student (Tsu, 1997). The experiment was focus on learning simple mathematics calculating. We conduct the experiment on college student, trying to find out if situated learning can be succeed on the domain of higher education. The students of Department of Microbiology have to take laboratory classes during the period of 4 years college. They always have the problem of how and where to apply what they have learned in the class. The instructive goals of laboratory class are diverse. Lazarowitz & Tamir (1992) believe that learning is a process of construction. Despite of learning the laboratory skill, oral discussion between instructor and students should be part of the learning process. In addition, a more inexpensive and more efficient instruction method, such as computer aided instruction or simulations, should be adapted in the class. Anchored situated instruction adapts computer technology to implement situated cognition theory. (Cognition and Technology Group at Vanderbilt,1990) In our software, we develop a pseudo but can be real situation, embedded the learning materials in the circumstances. Through the interaction between user and CAI software, learner can then practice the process of collecting and filtering information as well as the methods to solve the problem.

2 Design features of our approach

The script was written and designed by a professor of Department of Microbiology. We adopt several principles in our design.

1. Provide vivid circumstance. Multimedia allows us to design a vivid environment, so that the situation can avoid over-simplified and lack of context. (Yang, 1995). Multimedia also provides plentiful visual symbols, e.g. video images, graphic charts, sound as well as text to make the play more fun and close to real environment.

2. To hide useful information in the story, a learner may have trouble to transfer what he has learned to different situation if he was teaching in a simplified or provided obvious cue environment. Whereas, a learner can learn to justify what information can be useful and what information is not useful for solving the problem in a simulated situation.

3. To randomize the plot of the story, the learner can memorialize the plot if he has experienced in using this CAI software. This can then cause the learning process in vain. We use Random function in our design; one of the bacteria was picked randomly and then, in turn, develop different story.

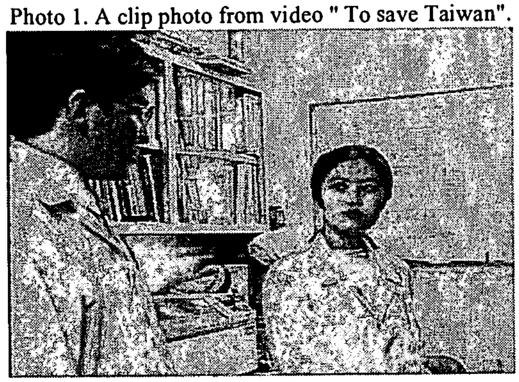
4. To have productive result, there may be only one answer or solution in a traditional instruction. However, in a real environment, there may be more than one solution to solve the problem. They may be pros and cons from one to one, but they may all workable. We do not provide firm answer to user instead, we provide an open-ended environment for user to construct his own path and solution.

3 The story

3.1 Outline of the story

There is a food mediated infectious disease occurs in a small town that locates at the seashore of Taiwan island. Within a few days, this infectious disease has spread to nearby counties and caused many cases of death. Tai-shang (see photo 1), the leading actor, a technician of the local public health administration office, is responsible for finding out the etiologic agent of the disease. In the story, Tai-shang is facing many challenges like the ones in real life. His girl friend, professor and colleagues are all in the plot and interactive with him. After the accident happened, he had faced the pressure from his superior, public media, even from a local councilor. He must acts like a detective who searches the cue and a scientist who seeks for the truth of problem. Finally, with the encouragement of his college instructor, Ta-shang successfully finishes his task.

Photo 1. A clip photo from video " To save Taiwan".



3.2 Goal of learning

a.• Cognitive aspect •

• a• Assessment of identifying the virus, fatal virus can not be classified from appearance. Thus, the learner

has to make a judgement base on the information gathered from the plot and then decide how to proceed the process of bacteria identification.

- b• Learning of the skills of bacteria identification, there are skills, e.g. Stain, biochemical test, can be practiced.
- c• Usage of bacteria identification index table, after the preliminary result of biochemical test, the learner needs to learn to use bacteria identification index table for final judgement.

b.• Attitude • •

- a• right attitude of science work, through playing the role in the game, the learner can identify the spirit of scientific work, diligence and concentration, as the attitude of being a scientist.
- b• Social caring, since the story has a local background, we hope the learner can improve the caring of local society by solving the problem for local society.

4 Evaluation of our experiment

There are four criteria of the evaluation of the designated software. The criteria is based on the character the teaching subject, human learning theories, and research on user interfaces• Kuittinen, 1998• : The criteria consist of four types of requirements: subject domain, instructional, user interface design and pragmatic matters. We invited two batches of domain experts, the faculties of Department of Microbiology and industry professionals to evaluate subject domain. They focused on examining if the concept and methods of this domain are generally applied in our software, which means they checked the relevancy to instructional aims. The group of 20 experts showed their positive opinion at the following chart.• Table 1• The instructional demand is a student-centered approach. We divide a group of 44 college students who are taking food microbiology into two groups. The 22 randomly selected members of test team used our software for average 6 hours in a period of a week. A cognitive examination was taken after one week. The result shows that the test team has better performance in cognitive aspect. Table2• The interactivity, display elements and connections between them are examined as the criteria of user interface. We use questionnaire to test team and found out that the team members show satisfaction of the user interface.• Table 3• As the pragmatic criteria, the hardware and software requirements are evaluated to see if a specific and /or expensive equipment or environment is required to use the software. Our software can be used in a common Microsoft Windows environment plus Pentium compatible personal computer. A learner can run our software either at computer room in campus or at his own PC.

Table 1. The result of experts poll

	number	Min	Max	Average	standard deviation	variance
Can the instructional goal of " assessment of identifying pathogenic bacteria " be reached?	12	3	4	3.67	0.49	0.242
Can the instructional goal of " learning the identification methods " be reached?	12	2	5	4.00	0.74	0.545
Can the instructional goal of " usage of diagnostic table for the identification bacteria " be reached?	12	2	5	4.08	0.79	0.629
Can the instructional goal of " influence on right scientific attitude " be reached?	12	2	4	3.58	0.79	0.629
Can the instructional goal of " influence on social caring" be reached?	12	2	4	3.25	0.87	0.750
Does the content of software cover" common foodborne pathogenic bacteria and their characteristics"?	12	2	5	3.92	0.79	0.629
Does the content of software cover" procedures of identification of pathogenic bacteria"	12	4	5	4.33	0.49	0.242
Does the content of software cover" knowledge for assessment of methods used in bacterial identification"	12	2	5	4.17	0.83	0.697

Table 2. Evaluation on the cognitive improvement of the software

Item		n	Average	SD	F-value	df	t-value
Score of Midterm examination	Control group	23	61.96	6.92	2.54	42	-0.34
	Exp. group	21	62.90	11.03			
Semester score	Control group	23	80.09	9.66	1.00	42	1.59
	Exp. group	21	75.48	9.65			
Cognitive Examination	Control group	23	29.74	6.11	1.09	42	-3.14**
	Exp. group	21	41.29	6.98			
Situated Questions	Control group	23	3.57	2.64	1.04	42	-3.73**
	Exp. group	21	6.57	2.69			
Questions on Microbiological Skill	Control group	23	26.17	5.07	1.08	42	-5.47**
	Exp. group	21	34.71	5.28			

Table 3. Evaluation of user interface of the software

	number	Min	Max	average	standard deviation	variance
I do not need tutoring before I use this software	21	2	5	3.95	0.92	0.848
I can easily know how to jump to next screen	21	1	5	3.76	1.18	1.390
I can exit the software anytime, anywhere.	21	2	5	4.52	0.93	0.862
I do not have the situation that I can not proceed because that I did not memorize the previous information while I use this software.	21	2	5	4.19	0.87	0.762
It's easy to modify my answer before I press the "confirm" bottom	21	2	5	4.10	0.94	0.890
I can receive the system feedback anytime when I use the software.	21	2	5	3.90	0.77	0.590
The system feedback is clear enough and no need to be explained.	21	2	5	3.81	0.81	0.662
I can use the software without reading the user's manual in ahead	21	2	5	4.19	0.87	0.762
I think the execution speed is proper to me.	21	2	5	3.95	0.80	0.648
I can handle the execution speed of my own.	21	2	5	3.81	0.75	0.562
I am satisfied the quality of the video.	21	1	5	3.29	1.01	1.014
I can use the software without knowing how to operate Window NT	20	3	5	4.55	0.60	0.366
Total score	21	39	55	47.81	4.12	16.962

5 Conclusions

We completed situated learning software "To save Taiwan" which attract the user to learn the microbiology knowledge and skills. This interactive software provides multimedia and random plots, which enable user to play the role in the story. It can also served as the tool to convey the right scientific attitude and social caring to learners.

The evaluation of this study showed promising results. It is possible and valuable to adapt situated learning to other disciplines in higher education. A disciplinary can construct the learning process on a situated

environment. By using the multimedia software, a learner can learn knowledge as well as the attitude in a near true story. He can then realize the meaning of the knowledge and identify himself with what he has learned and then applied to real environment.

References

- 1• Hsu, H.Y.• "Design of anchored instruction" Audio-Visual Instruction bimonthly. 37(1), page14-24, (1995)
- 2• Yang, C. H.• "The situated instruction theory and hypermedia learning environment"• Instruction technology and media• August, 1995• page41-48• (1995)
- 3• Brown, J. S.Collins, A., & Duguid, P., " Situated cognition and the culture of learning", Educational Researcher, 18,32-41• (1989)
- 4• Cognition and Technology Group at Vanderbilt., "Anchored instruction and its relationship to situated cognition ", Educational Researcher, 19,P2-10, (1990)
- 5• Lazarowitz, R., and P. Tamir.. "Research on using laboratory instruction in science. In: Handbook of research on science teaching and learning". Ed. By D.L. Gabel. P. 94-127. MacMillan Publishing Company, New York., (1992)
- 6• Kuittinen, M. "Criteria for evaluating CAI applications", Computer & Education 31, 1-16, (1998)
- 7• Winn, William,"Instructional design and situated learning: Paradox or partnership?" Educational Technology 33(3), page 16-21,(1993)

An approach to modeling an educational domain

Gennadiy ATANOV
Donetsk Institute of Social Education; DISO, Donetsk, 83000, Ukraine
E-mail: atanov@dongu.donetsk.ua

The paper develops a topic of construction of the normative student model. The subject student model is a part of it representing a sum of demands to the curriculum of the subject, to students' knowledge and skills, and a semantic model of the domain. The subject student models pick out the educational domains from all the multitude of the domains, so the subject model is a model of an educational domain. Examples in physics are given.

Keywords: **student modeling, domain modeling, knowledge, skills, semantics**

1 Introduction

A fundamental concept of modern didactics and pedagogical psychology is the student (learner) model. It arose within computer technologies of education and was provoked by the necessity to formalize our representation about students. Of course such representations had been worked out long before any appearance of computers, and definite formalization of them began together with didactics. But it is computer technologies that gave a new impulse to development of these representations, transformed them into an object of deep investigations, transferred to a qualitatively new level [8,9].

In the widest sense, the student model is our knowledge about a student. There are two sides here: (1) knowledge about how the student is, and (2) knowledge about how we want to see him/her. The first knowledge is determined by the way of analyses of student's behavior, and it is natural to call it a behavioral student model. It is changing together with the student's change therefore it is also called dynamic, or current, one. Mechanism of construction of this model is the cognitive diagnostics [9].

Knowledge about how we want to see students, that is, demands to their final state is a normative student model. As a rule, this knowledge is various. It consists of demands to personal qualities of future specialists, their professional qualities and skills, their knowledge and skills in different subjects, characteristics of their physical and psychological state, and so on. The final aim of teaching is achievement of such a state when the behavioral student model concurs with the normative one.

2 The subject student model

A part of the normative student model determining domain knowledge is a subject student model [3]. In knowledge engineering, it is called expert knowledge, or domain model [5,6]. The subject student model picks out the educational domains from all the multitude of the domains, so the subject model is a model of an educational domain, or a model of a subject. Let us note that if the dynamic modeling is quite a developed branch of Artificial Intelligence, the domain modeling is developed to a lesser degree. It is clear, as specialists in Artificial Intelligence, as a rule, are not the ones in any other domain.

Under knowledge they understand the main conformities to natural laws helping us to solve particular problems (production, scientific, economic, and others) [5]. Facts, concepts, algorithms, intercommunications, rules, strategies of making decisions, and so on make up knowledge. The pithy sense of the concept «knowledge» is that knowledge reflects our imagination about domains and expresses a system of concepts, as well as relationships and dependencies between them.

According to the classification, there is a division of domain knowledge into declarative and procedural ones.

The first is statements about properties of the subjects of a domain and relationships between them. The declarative knowledge is often called a factual one, and this reflects its essence very well. The procedural knowledge describes the order and character of the transformation of the domain objects. Its another appellation is rules. In our opinion, it is not quite right, as the declarative knowledge, giving relationships between the objects, is also rules. Thus the procedural knowledge is not simply rules but rules of transformation.

The final aim of instruction is formation of way of acting. The way of acting is realized via skills in the practical activity [7]. The mechanism of this is operation with knowledge (both the declarative and procedural) being displayed in the behavior of a person. Therefore, in a wide sense, skills are attributed to knowledge, namely behavioral one [9]. The procedural knowledge is realized in skills. And sometimes, skills are called the procedural knowledge but, as we could see, the term "procedural knowledge" has been already occupied. Definition "operation knowledge" reflects the essence of the things clearly and in the most unambiguous manner. Thus, the subject student model has to contain skills that are to be formed in the process of instruction. Let us call a list of such skills the operational subject student model.

The declarative component of the domain knowledge makes up a semantic part of it, namely the semantic student model.

One of the distinctive properties of knowledge is that it has a certain structure. It is very important, especially for the instructional material, to define its structure. It is well known that to master a portion of the instructional knowledge is to determine its place in the structure of the instructional material. Therefore, one of the problems while constructing the subject student model must be determination of the subject knowledge structure. Studying the structure of the instructional material is a theme of an independent important and deep investigation. The subject student model must give more or less extended ideas about what the subject knowledge is. Such ideas are an essential part of any curriculum. A usual way here is a thematic approach when themes are enumerated. Let us call a list of themes liable to studying the thematic subject student model.

In teaching, it is very important methodologically to determine which role either knowledge plays and which functions it carries. In other words, it is necessary to fulfil a functional structuring of the instructional knowledge. It can be done with the help of a list of functional rubrics. The functional knowledge will be determined in such a way. Within it, there is knowledge performing both nontransforming functions (for example, facts, conclusions) and transforming ones (algorithms, methods, instructions). The functional knowledge makes up the functional subject student model.

In such a way, we suggest a four component subject student model consisting of thematic, functional, operational, and semantic parts. Such a subject student model in physics is carried out at the physics and didactics of physics department of the Donetsk State University [1-3].

3 The thematic subject student model

The thematic subject student model has been well known for a long time. In essence, it is a usual curriculum of the course, its program. It is built just according to the thematic principle, sections and themes liable to studying are enumerated in it. The model reflects the structure of the course. The program can be worked out in detail to different degree but it is always neither knowledge itself, nor its content but its names. In fact, this is a define characteristic of the subject knowledge, some knowledge about the subject knowledge. Knowledge about knowledge is called metaknowledge. Thus, the thematic subject student model is a metaknowledge.

It is a natural and convenient model for planning and organizing the instructional process. The more, it is an obligatory normative document. Preparation of any course begins with its creation (that is, creation of the course curriculum). Nevertheless, it is excessively general to use it for diagnostics.

As a rule, knowledge in many computer tutoring systems is structured according to the thematic student model.

4 The functional subject student model

The functional subject student model shows which role either knowledge plays; and it is also metaknowledge. It has a define structure in the horizontal direction, which may be given with the help of some rubrics. The role of knowledge and its functions depend on a particular subject. For example, we picked out the following rubrics for physics courses: *concepts, wordings, laws, properties, consequences, conclusions, reasons, formulas, equations, models, methods, and algorithms* [3]. The rubrics have a filling that, nevertheless, also does not reflect semantic of the subject and is metaknowledge.

It is the subject student model that allows working out in details what students must know. Let us give an example from the molecular physics. Students have to know: definitions of the concepts: *mole, thermodynamic system, pressure, temperature, density, concentration, ideal gas, equation of state*, and so on; wording and consequences of: *Pascal's law, Maxwell's and Bolzmann's distributions, Kirchhoff's law*, and so on; deductions of: *the mine equation of kinetic theory, equation of the adiabatic process, law of atmospheres*, and so on.

5 The operation subject student model

As it was noted, the operation subject student model is a list of skills liable to mastering by students. Let us note that skills in education make up a hierarchical system [2]. It consists of five groups of skills: fundamental, methodological, general, inter-subject, subject. Subject skills take the highest position in the hierarchy of skills.

We pick out three classes of the subject physical skills: general, particular, and experimental. The general skills are, on the first hand, methodological ones. Spectrum of the particular skills is far wider, for example, there are more than 200 them in the list in physics. According to the contents of the instructional material, the following skills are picked out: *to find, to determine, to fix, to build, to obtain, to calculate, to compute, to estimate, to distinguish, to pick out, to sort, to take into account, to represent, to traverse, to decompose, to compose, to generalize, to put in practice, to use, to formulate.*

There is a fragment of the list of the skills below:

3.1. General skills

To analyze physical processes and phenomena, to estimate orders of physics magnitudes and determine essential factors, to build physical models, to build mathematical models of particular physical processes and phenomena, to determine boundaries of applicability of the models, and so on.

3.2. Particular skills

3.2.2. Molecular Physics and Thermodynamics

To estimate quantity of particles and their mass in particular conditions, to determine parameters of state of gas, to determine number of degrees of freedom and molecular mass of a gas and mixture of gases, to determine possibility of the use of the model of an ideal gas, to make use functions of distribution to find average values of physics magnitudes, and so on.

Experimental skills are divided into three groups: *to measure physical magnitudes*; *to reproduce independently physical phenomena and processes; experimental particular skills.*

There is a hierarchical structure of the subject skills corresponding to the development of the subject in instruction. Besides that all of them also have a definite structure in the horizontal dimension because they are complicated, or composed, skills. In order to master them, a wide spectrum of skills both of the lower levels and subject is necessary. For example, skill *to solve physical problems* is composed of ten simpler skills: *to pick out the necessary information from the condition of a problem to solve it, to code the condition of the problem in a word form, to draw a picture to the problem, to choice a rational method of solving*, and so on.

6 The semantic subject student model

Semantic knowledge in different subjects is contained in textbooks, other training literature. There are two parts in the content of any textbook: CON-1 and CON-2 [7]. CON-1 is knowledge making up the content of

a domain directly, CON-2 is knowledge attending the CON-1 (for example, knowledge from other subjects, interpretations, explanations, examples from life). In fact, it is the CON-1 that is the semantic knowledge of a domain. Nevertheless, this knowledge is not picked out especially, it is distributed all around the textbook, interacts with another knowledge, and is not formalized.

Semantic knowledge represents the declarative component of the subject knowledge as the procedural knowledge is realized in skills (operational knowledge). Thus to construct a semantic student model on the basis of a textbook, it is necessary to pick out domain facts from it and group them in a definite order. According to their structure, facts may be of a great variety. As a rule, they are compound ones. Nevertheless, elementary facts may be picked out that, appearing in different relationships, form the compound facts. General questions of representation of facts in instruction are considered in works [4]. For example, expression "*Translational motion is the motion that all the point of a solid body have identical trajectory*" is a compound fact as it can be represented as a set of the following elementary facts: (1) *a solid body moves; (2) all the point of the body have identical trajectory; some motion is called the translational one.*

One can easily see that the elementary facts do not carry any semantic loading of the domain although they contain domain terms. Only on gathering together in a compound fact they acquire some doma in sense. Such compound facts are finished thoughts and they are represented by finished sentences, or expressions. Let us call them the *semantic* facts. As a matter of fact, the semantic facts are a unit of the domain knowledge, as smaller portions of it have no domain sense. The objects of the expression are concepts, phenomena, processes, laws, principles, theorems, conclusions, consequences, reasons, properties, rules, and so on.

It is the full set of the semantic facts that is the semantic subject student model. The order of their disposition is subordinated to the logic of the development of the course.

Such a semantic subject student model was firstly constructed in Gas Dynamics and than in Physics [1]. Those were very small brochures because there were no calculations, proofs, and explanation in them. Nevertheless, they contained all the statements of the courses. These brochures received the title *semantic synopsis.* As an example, there is a fragment from a physics semantic synopsis below:

3.1. The elementary work of a force is defined as the scalar product of the elementary displacement of the point of the force application.

3.2. The work of a force is defined as a line integral from the elementary work along the trajectory of the point of the force application.

3.3. The unit of the work is one joule that is equal to a work done by a force of one newton on a displacement of one meter.

In the opinion of instructors and students, the synopsis turned out an effective means while consolidating the instructional material, preparing to seminars. It helps to size up the structure of the instructional material, pick out and easily memorize the most essential its moments. It is very important that student remember them for a longer time.

The synopsis allows carrying out fast and regular control students' knowledge during a lecture. In this case, the expressions serve as a base for the open type test tasks being created by missing some keywords in the expressions. Students note a great value of the synopsis while preparing to the examinations when there is a danger do not pick out and master the main statements of the course.

Let us note that the semantic facts are distinctive rules as they define character of relationships between the elementary facts. In other words, they are rules according to which the elementary facts are connected between themselves. This circumstance stipulates possibility to represent the semantic knowledge by means of the production method. It is done with the help of rules of a kind "if A than B" where A and B are some facts. An example of such a representation of the above mentioned definition of the translation motion is given below:

If < *a solid body moves*> and
< *all the point of the body have identical trajectory*>
than <*such a motion is called the translational one*>.

Each of the expressions may be represented in such a way. Thus the production knowledge base of the subject will be constructed. Its constructing is considered in details in work [4]. As our practice shows, constructing production knowledge bases by students while learning is an effective kind of learning activity.

7 Conclusion

An approach to construction of the subject student model as a part of the normative one is described. The model consists of four components: thematic, functional, operation, and semantic. The thematic model gives ideas about the structure of the subject, the semantic one reflects its content, functional one determine what students have to know, and operation one does what students have to be able. The approach allows constructing more detailed current student models and reaching the main aim of teaching, namely forming the way of acting, more successfully.

References

[1] Atanov, G.A., Belaya, T.D., Beshevly, B.I., etc. "The base synopsis in physics". Kyiv, NMK VO, (1993) (in Russian).

[2] Atanov, G.A., Efros, T.I. "System of skills in instruction as a part of the learner model". Proc. of the Intern. Conf. on Computer Assistant Learning CAL-97. Exeter, UK, pp. 369-372, (1997).

[3] Atanov, G.A., Martynovitch, N.N., Tokiy, V.V. "Curriculum of Physics Course as a Student Model". Proc. of the Intern. Conf. on Computer Technologies in Education ICCTE'93. Kyiv, Ukraine, p. 138 (1993).

[4] Atanov, G. A., Pustynnikova, I. N. "Representation and Structuring of Domain Knowledge by the Semantic Networks and Productions Methods". Proc. of the 8th Intern. PEG Conf.: Meeting the Challenge of the New Technologies. Sozopol, Bulgaria,, pp. 392 - 393 (1997).

[5] Brachman, J., Levesque, H.J., Reiter, R. "Knowledge representation". MIT Press, (1992).

[6] Dean, T.L., Allen, J., Aloimonous, J. "Artificial intelligence: Theory and practice". Benjamin/Cummings (1994).

[7] Mashbits, E.I. "Psychological and pedagogical problems of computer assistant learning". Pedagogika, Moscow (1988) (in Russian).

[8] Self, J. "Dynamics of Learner Models. Artificial Intelligence and Education". IOS Press, Amsterdam (1994).

[9] Wenger, Å "Artificial intelligence and tutoring systems. Computational approaches to the communication of knowledge". Morgan Kaufmann, Los Altos (1987).

Design and Implementation of Teaching Models in Web-Based Teacher Training

See-Min Kim*, Shin-Chon Kang, Young-Kyun Back****
** CRADLE, Tokyo Institute of Technology*
2-12-1, Ookayama, Meguro-ku, Tokyo, Japan 152-8552
Tel: +81-3-5734-3233, Fax: +81-3-5734-2995,
E-mail: kim@ak.cradle.titech.ac.jp
*** Korea National Universty of Education*
Darak-ri, Kangne-myon, Chongwon-kun, Chugbuk, Korea 363-791
Tel: +82-431-230-3431, Fax: +82-431-233-0664,
E-mail: skytop@chollian.net

The reform of teacher training started in May 1995 in the Republic of Korea with reform of the educational system. The core of the reform was reinforcement of teacher training activity and introduction of a DTTS(Distance Teacher Training System). Then, in order to introduce a DTTS, the project for distance teacher training model development started in September 1997. This paper is related to a design and implementation of a teacher model in a DTTS. The teaching models of the following 4 types were carried out. 1) Problem-Solving type, 2) Seminar type, 3) Lecture-Practice type, 4) Courseware type. This system was in operation from October 1998. Current problems of this teacher models include: 1) Poorness of course contents, 2) The difficulty of checking a learning process, 3) Insufficiency of feedback to a trainee etc.

Keywords: **Distance Teacher Training, Teacher Model, Web-Based Learning**

1 Introduction

In Korea, reform of teacher training started on May 31, 1995 with the announcement of a reform of the educational system proposal. Philosophical bases for reform of teacher training are the spirit of the opened education, enshrining the principles of, opened an educational opportunity, the learning speed, the contents of learning, and the learning method, etc. The contents of reform are as follows[5]:

1) Obligation of periodical training;
2) Execution of distance education that introduced high technology of information communication engineering;
3) Reflection to the personnel affairs and the salary of a training result;
4) Authorization of a special course completion result in a graduate school and a social-education organization;
5) Attempt to the improvement of the training organization that enabled selection of the training organization by the teacher and let competition pass in qualitative.

These are summarized the following: 1) reinforcement of teacher training activity 2) introduction of a DTTS(distance teacher training system). It aimed at an expansion of the training opportunity, and overcoming restriction of time and space, with a reduction of training expenses. The project of DTTS development started in September 1997. It was sponsored by the Korea Multimedia Education Center. This project was divided into 4 sub-projects: Develop a training support model, design for teaching model, courseware development, and development for system management model. This paper is related to a design and implementation of a teacher model in a DTTS.

A teacher model is dependent on the contents of course, the learner characteristic, learning environment, etc. [6]. According to the questionnaire for the teachers and educational professionals of Choi [2], the suitable course for distance teacher training is as follows.

1) Various culture subjects (humanities a subject and a theoretical field).
2) Teaching methods expected such as discussion and workshop, then a lecture.

In Korea, as a training course into the distance teacher training, the culture subject of 11 was chosen. These were, "Foreknowledge of the future society and a counter plan", "Understanding of traditional culture", "The world in the 21st century and the Korea", "An information society and a computer", "Environment and education", " Raising of national morality nature", "An information society and multimedia education", "Theory and practice of open education", "The direction of the educational system reform and school reform", "Education of humanity and originality", "Education for a unification counter plan".

In consideration of the characteristic of subjects and learner, strategies of WBI(Web-Based Instruction)[1], the teaching model of the following four types was proposed. 1) Problem-solving type, 2) Seminar type, 3) Lecture-practice type, 4) Courseware type. These are described at length in sections 2-4.

2 Design of the Teaching Model

In this project, the model of distance teacher training was divided into the macro model and the micro model, and was developed accordingly. A macro model is the framework of the whole DTTS, and a micro model is the course of training, that is, a teaching model. A macro model and a micro model are unified and distance teacher training is managed.

2.1 Web-Based Instructional Strategies

The acquisition process of the knowledge in WBI and the approach of the learning of constructivism are very similar. The most basic principles of constructivism concern fundamental philosophical assumptions about knowledge and learning[4]. The first, more generally accepted principle is that what a person "know"is not passively received, but actively assembled by the learner. The second principle is that learning serves an adaptive function. That is, learning is not the storage of "truths,"but of useful personal knowledge. This means the importance of the context of learning. Context has a lot to do with what is perceived as useful knowledge and how what is learned is integrated with existing knowledge. And the assumption that education is about acquiring universal truths. Since each person has different experiences and constructs an individual account of these experiences, each persons' s reality is slightly differenbt. New expereriences are interpreted within the context of these individual realities, implying that each person "know"a particular thing in a slightly different way.

We introduced the application of a repertoire of cognitively oriented instructional strategies implemented within a constructivist and collaborative learning environment, utilizing the attributes and resources of the internet[1]. The instructional strategies may be designed the following ways:

1) Support to the interaction between a lecturer- learner, and a learner-learner.
2) Introduce a hyper-textual function and support individualization learning.
3) Various learning materials provide in real time or non-real time (multimedia support)
4) The contents of learned and an evaluation results are analyzed rapidly and correctly, and it offers feedback to learner and system side.
5) Provide of DB Retrieval Function for learning information
6) It cooperates with other educational networks, and mutual reference can be carried out.

2.2 The contents-characteristic of subjects

The courses designed by the DTTS were culture subjects of 11. Generally, the contents of culture subject in a training course are unlike 'learning subject' that gains new knowledge. The culture subjects are mainly implicated that the contents of knowledge or skill newly asked for with a social change. And it takes into consideration that learning environment is being home, designed so that it might participate in learning not passive position but positively.

1) Show many concrete examples so that positive and concrete study can be performed.
2) Show or introduce the newest data and the newest present condition. And a learner performs creation of a report, discussion, and practice based on this.
3) In order to check rationally learning process which is the blind spot of home study, a small-scale subjectivity formula or report is required of an evaluation item.

4) The teaching contents are selected based on an opinion of the highest specialist of the field.

2.3 The learner-characteristic of in-service teacher and consult the needs analysis

In designing we considered the needs analysis of teacher needs[2]. And also considered the spirit of teacher training reform, that is the open educational opportunity, the learning speed, the learning contents, and the learning method, etc.

3 Proposed Teaching Models

3.1 Problem-Solving type Model

This model is used the following three subjects with "understanding of tradition culture", "information society and a computer "and "environment and education". The characteristics of contents of these subjects have much problem socially now. For example, the latest children cannot have understand about traditional culture, and do not understand value either. Moreover, although environmental problems are scattered in the familiar place, the problem consciousness does not exist. It is the learning which considers how it is efficiently introduced, how solving these problems at an educational field.
Problem-Solving type model is shown in **Figure 3.1**.

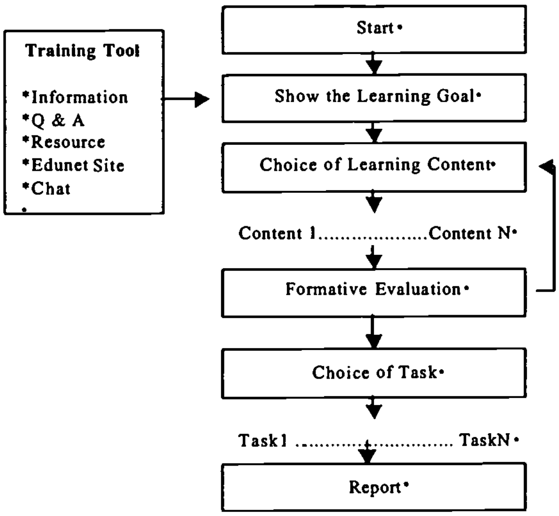


Figure 3.1 Problem-Solving type Model

3.2 Lecture-Practice type Model

Two subjects, "An information society and multimedia education" and "Theory and practice of open education" used this model. It is designed so that it might practice how theoretical knowledge may be reflected in the actual educational field. Through these courses, teacher can to help a child learn the capability that it can count measure to an information society, and how a teacher should just utilize the concept and the technology of multimedia for lesson activity. And more recently, it often pleads the open education. While introducing the concept of the open education and the example of the practice, teacher also gives an opportunity to consider an educational-practical use proposal directly.

3.3 Courseware type Model

Since three subjects, "Foreknowledge of the future society and a counter plan", "The world in the 21st century and the Korea", " Raising of national morality nature" were the contents of the type learned as new knowledge.
After having chosen the learning unit from the table of the learning contents, and learning using various data, composition which finishes a course through formation evaluation and generalization evaluation was designed.

3.4 Seminar type Model

This model uses the following three subjects. That is "The direction of the educational system reform and school reform", "Education of humanity and originality", "Education of a unification counter plan". At first a group is constructed by the theme and to be performed learning in Seminar form so that learner might have an opportunity to expand the view and develop the main point by the mode of opinion exchange.

Seminar type model is shown in **Figure 3.2** below.

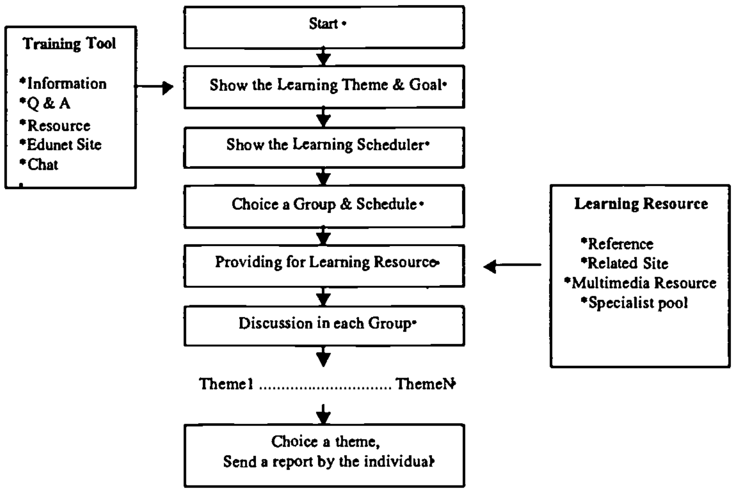


Figure 3.2 Seminar type Model

4 Implementation

The proposed model went into test implementation from October 1998. And now the model is used for qualification study of elementary and the 1st class positive teacher of middle, and general training of an elementary deputy schoolmaster.
As problems of this teaching model the following may be mentioned: 1) Poorness of course contents, 2) The impossibility of checking a learning process, 3) The insufficiency of feedback to a learner etc.

5 Conclusions

The distance education which used the high technology of information communication engineering in Korea started in 1997[3]. Insufficiency of a lecturer and restriction of a training opportunity are well said as a problem in teacher trainings. As one proposal for solving this problem, the project of "Development of a distance teacher training system" started and virtual teacher training actually started from October 1998. Thereby, little by little, teacher training environment becomes better and we think that the opportunity of training and the improvement in qualitative teacher training may also be anticipated.
There are problems that should still be correct and complement continuously in this training system. But the problems that should solved urgently are preparing the method of evaluation, the monitor staff who helps training, and a specialist pool.

References

[1] Bijan B. Gillani & Anju Relan., "Incorporationg Interactivity and Multimedia into Web Based Instruction", Web-based instruction, Badrul H. Khan, (Eds.), Educational Technology Publications, Inc,. pp. 231-237, (1997).
[2] Choi, Sang-gun., "Development of Distance Teacher Training System", Seoul: Korea Education Research Institute, (1995).
[3] C. H. Lee., "Pre-service & In-service Teacher Training for Computer Education in Korea," Advanced Research in Computer and Communications in Education. G. Cumming et al.(Eds.), IOS Press, pp. 433-440, (1999).
[4] Mark Grabe & Cindy Grabe., "Integrating Technology for Meaningful Learning", Houghton Mifflin Company, pp.32-76, (1998)
[5] Pang, Myung-suk., "Teacher's Information Literacy Training in the republic of Korea", Seoul; Korea Multimedia Education Center, (1998).
[6] Willis, B., "Instructional development for distance education," (ERIC Document Reproduction Service NO. ED 351 007), (1992).

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-constructivist 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.

Is Everyone on Board: Learning Styles and the Internet

Michelle Hsiang*, Ellen Storey Vasu, Marsha Alibrand***, Nancy Atkins**** and Jane Steelman*****

** Research Triangle Institute/ NC State University. Email: mhsiang@rti.org*

*** NC State University. Email: esvasu@unity.ncsu.edu*

****NC State University. Email: marsh@cape.com*

*****NC State University. Email: atkinsn@he.orange.k12.nc.us*

******NC State University. Email: ravendoc@aol.com*

For many years, educators and practitioners have been implementing, enhancing and innovating variety of teaching methods to best fit students learning styles for eliciting the potential of students. As stated by Corno and Snow [2], "the success of education depends on adapting teaching to individual differences among learners", the teaching methods taught are to accommodate, meet, and elicit the diverse learning needs. Technology is becoming accessible to most segments of the United States population. As more and more classrooms are connected to the Internet and online-lesson plans are adopted to teaching and learning, it is important for teachers to ensure that the diverse needs of every student is addressed. This research study contained the quantitative analyses relative to learning styles and web design.

Keywords: **Humanities and Learning Technology, Instructional Design, Web-Based learning**

When computer technology increased its popularity in 1980's, Computer-Assisted-Instruction (CAI) in the form of drill, practice and tutorials was superior to traditional instruction [1] and outperformed those who received traditional instruction [7]. While providing feedback to reinforce learning in CAI, Pritchard [6] recommended that the use of computers in CAI require a specific learning style of paying attention to details for accuracy, so that students are able to work alone. Davidson et al [3] further examined learning styles and performance in computer concept and programming skills in BASIC, and found that learning styles had a significant effect on performance of a computer course. By 1997, 72% of the schools in the USA had online access. As teachers adapt their teaching to the use of the World Wide Web as a medium for resources, and to publish their class websites, the information delivery system has been changed from paper format to digital format and from fixed text to unlimited hypertext. The visual graphic representation has been switched from static to animated/multi-dimensional and from limited colors to millions of colors. With the advance of the technology, sound and movies can be incorporated into webpages to enhance teaching and learning environment. With the release of many HyperText Markup Languages (HTML) editors, e.g., Adobe PageMill, DreamWeaver, Front Page, it becomes very easy for anyone to create and publish webpages, therefore it is essential for educators to investigate the different learning styles of individual students when designing webpages.

Study Purpose and Sample Setting

The purpose of this study is to examine two different webpage designs regarding to students learning styles. A total of 44 students who enrolled college courses in graphic design, computer application and web design were selected in the study. Students in these classes had little or some knowledge of the Internet and Webpage design.

The two web designs were developed by the authors and used for the study: one-frame versus two-frame designs with the incorporation of colors, animation, buttons, and hypertexts. The one-frame design used a top-down sequential technique for web design. To begin, users must access from the main menu in order to navigate to other pages. The two-frame web design contained two displays located side-by-side. The left-frame normally contains the potential links, the right-frame displays the corresponding information. Users can make random selection of different links at any given time provided on the left-frame that served as the main menu.

Measurement and Procedures

In the beginning of the semester, the Gregorc Style Delineator [4] was administered and the scores were tallied to determine students prefer learning styles in (1) Concrete sequential; (2) Abstract sequential; (3) Concrete random; or (4) Abstract random. At the end of the semester, students were given an Uniformed Resources Links (URL) to review the two different styles of web designs as mentioned earlier. After review, an instruction was provided for the students to fill out an open-ended questionnaire to reflect their selection and to make their comments.

Selected Results:

Two-frame selection: Students preferred the two-frame design to the one-frame arrangement with a ratio of approximately 3:1. This again stressed the importance of design in CAI that emphasized gaining attention, guiding learning, informing learners of objectives, and presenting stimuli with distinctive features. The reasons why users were in favor of the two-frame design included that it was easier to navigate with left-frame controlling the right-frame. With all the links listed on one-frame and information displayed on the other, it provided a quick access to the viewer.

One-frame selection: Students who preferred the one-frame design to the two-frame one like the fact that it was easy to follow and less confusion, simple but effective. Information straight down on a page was easier to read and to understand than a two-frame design. It kept attention intact and was readily for research. Some found that it was easy to use for computer illiterate people.

Discussion

The two-frame design is a newer approach than the single frame design. Students used to the one-frame design and some still prefer the same way of accessing information, even though the two-frame design has pleasing results and is reportedly easier to use than the one-frame design. In summary, this research suggested that the major reasons why the students disliked the two-frame design were because they were simply unfamiliar with the structure. Additional training and more exposure to the two-frame design would help them overcome the barrier. As the popularity of the Internet increases and the HTML editors become easier to use, it is important to emphasize these design factors, so that the webpages can be designed more accessible and user friendlier as technology advances.

Reference

[1] Burns, P. K. & Bozeman, W. C. (1981). Computer Assisted Instruction and Mathematics Achievement: Is there a Relationship? Educational Technology, 21, 32-37.

[2] Corno, L., & Snow, R.E. (1986). Adapting teaching to individual differences among learners. In Handbook of research on teaching, 3rd ed. Ed. M.C. Wittrock, New York: Macmllan.

[3] Davidson, G., Savenye, W., & Orr, K. (1992). How do learning styles relate to performance in a computer applications course? Journal of Research on Computing in Education, 24, 348-358.

[4] Gregorc, A. (1976). Learning Styles Inventory. Storrs: University of Connecticut.

[5] Kulik, J., Bangert, R. & Williams, G. (1983). Effects of Computer-Based Teaching on Secondary Students. Journal of Educational Psychology, 75, 19-26.
[6] Pritchard, W.H. (1982). Instructional Computing 2001: A Scenario. Phi Delta Kappan, 65, 322-325

Learning Digital Logic Design by Concept Mapping

Hsiu-Mei Lin
Dept. of Electrical Engineering
Chinese Military Academy, Taiwan
hmlin@cc.cma.edu.tw

The Internet and the WWW provide an ideal vehicle for interconnecting the concept networks to assist learning. This paper proposes a framework of concept mapping via the WWW for the learning of digital logic design. The concept-mapping program is an active learning environment, which offers a flexible learning context to all learners. In this learning environment, learners have considerably freedom to: (1) navigate the wide knowledge domains of digital logic design and the applications, (2) choose the direction of the materials they need, and (3) collaborate with their peers in the classroom or out of the classroom. Concept mapping by WWW can be expected to provide more for learning than other teaching schemes.

Keywords: **Concept mapping, WWW, Digital logic design.**

1 Introduction

Teaching method and learning environment at Chinese Military Academy are still centered around the two traditional teaching modes: lecturing the textbooks and memorizing the contents under conventional classroom setting. Many cadets are accustomed to learn from teacher' s lecture; then, memorize textbook' s materials to pass examinations. In the minds of these cadets, learning means memorizing the test materials by rote. They seldom think about "why to learn" and "how to learn," and care less about knowledge construction and application. This learning attitude is not any better in learning the Digital Logic Design course. Although the instructor has been trying to adopt different teaching methods and diverse classroom activities to motivate them, an optimal learning environment to construct the knowledge of digital logic design needs to be established first.

Digital logic design consists of the basic concepts and tools of logic circuits used in designing digital hardware. The aim of the course is to understand and to design digital systems for computers, control systems, etc. The design task has a wide range of various complex concepts and techniques; learners always have learning difficulties in this subject matter. One of those learning difficulties is the integration of the concepts of the components (e.g., decoders, multiplexers, flip-flops, registers) with the practical system design. In another word, learners have difficulty understand the new knowledge using what they already learned. In addition to that, they have problem of connecting the real object with the abstract concepts. For example, an overflow can occur while processing an arithmetic operation, but learners always confuse why an overflow occurs and how to detect whether the overflow occurs or not. For the students, it is really a problem under the conventional learning context to make the abstract logical concepts meaningful.

To facilitate learning, a number of researchers (e.g., [2]; [5]; [11]; [13]) recognized that concept mapping could be widely applied as a vehicle to improve learning and metacognition. Hence, concept maps could be used to develop an innovative digital design learning program. The purpose of this paper is to construct a framework of concept mapping via the WWW for learning digital logic design. The concept-mapping program is an active learning environment to offer a flexible learning context for different kinds of students regardless of their background, experiences, learning styles, and learning pace. It allows an interactive, step-by-step construction of logic design skills for a variety of combinational and sequential circuits. In this learning environment, learners have considerably freedom to: (1) navigate the wide knowledge domains of digital logic design and the applications, (2) choose the direction of the materials they need, and (3) collaborate with their peers in the classroom or out of the classroom.

2 Meaningful Learning and Concept Mapping

For learning purposes, the learning materials used in teaching should be understandable. To do this, learners have to construct the concepts and the relations among them. This step is necessary in order to make learning meaningful to the learner. The literature of meaningful learning and concept mapping are reviewed in this regard.

2.1 Reviews of Meaningful Learning

Traditionally, textbooks and learning materials are linearly written, and lectures are also linear in nature. Teachers usually separately explain concepts and knowledge. Students learn the concepts and its contents separately. Then, they memorize concepts under isolated schemata. Such unconnected knowledge is randomly stored in either short-term or long-term memory and is less retrievable. This learning process greatly contrasts with the organized knowledge in human minds, which could be a semantic web for constructing the whole knowledge domain. In essence, learning should involve many interconnected pieces of information. New pieces of information get added to this connected set of ideas and become interrelated to the information that is already there. This forms a massive web of ideas and leads us to related information that becomes integrated as personal knowledge ([1], [9]). That is, the learner has to make the assimilation of new concepts into existing cognitive structures in order for learning meaningfully. Therefore, to acquire meaningful learning, the learner requires a deliberate effort to relate new knowledge to relevant concepts he already possesses. To facilitate this process, the learner has to know the "conceptual starting place", and the linking of the associated concepts. In this sense, concept mapping could offer as a means for course design, which promotes the development of a structured course within a good pedagogical framework. By means of concept maps, learners could foster meaningful learning.

2.2 Concept Mapping as an Educational Tool

Concept mapping is a technique for representing knowledge in graphs. Knowledge graphs are networks of concepts. Networks consist of nodes and links. Nodes represent concepts and links represent the relations between concepts. Concept mapping could be used for several purposes: (1) to generate ideas, (2) to design a complex structure, (3) to communicate complex ideas, (4) to integrate new and old knowledge, and (5) to assess understanding or diagnose misconceptions [6]. It can be extensively used as an educational tool to promote meaningful learning. A concept map represents a general view of a subject that can be examined in greater depth. In a concept map, one dominant concept is defined in terms of subordinate concepts, then clarified and illustrated with concrete evidence or instance. Finally, a complete concept map is woven together with explanatory crosslinks [3]. In this paper, the author addresses teacher- made maps, which intend to guide learners toward general understandings of the materials they have to learn in regard to digital design. Moreover, the concept maps may provide learners with methods and skills of researching, analyzing, synthesizing, and evaluating relevant information in any learning field.

2.3 The Learning Benefits of Concept Mapping via WWW

Traditionally, a concept map used in teaching is regarded as a tool to describe a set of subject concepts by the paper and pencil. The paper-and-pencil has some restrictions to track all possible relationships between the nodes of a big map. However, while a concept map developed through the computer, especially on the WWW, can be implemented as a hypergraph, where a node may lead to a more detailed subpage. The learners could use the characteristics of hyperlinks to navigate the nonlinear connections and search for different paths between the nodes to explore the contents in whatever order desired. In brief, the concept map can assist the learners in seeking out the "big picture" of the domain of the subject ([4], [6], [10]). Kommers & Lanzing [6] proposed that concept mapping through interactive multimedia is an effective mental learning strategy to empower learning. Especially, the wide reach of the Internet network, coupled with the hypermedia capabilities of the computers it interconnects, has made the WWW as a vehicle for delivering knowledge [7]. Kommers & Lanzing [6] concluded that the benefits of using concept mapping on the WWW include: (a) ease of recognition, (b) the possibility to quickly scan picture and find differences or keywords, (c) compactness of representation, and (d) the observation capability.

3 The WWW Environment for Learning Digital Logic Design

The Internet provides an ideal vehicle for interconnecting the concept web to assist learning. It is a rich-resourced platform for learners obtaining a large amount of information. Especially, while learners navigate on the WWW, they respond to the stimuli that interest them. This guides them to related information that becomes integrated as personal knowledge [12].

3.1 The Characteristics of the Learning Environment

Taking the benefits of the WWW, the learning environment for digital logic design is a web-based environment designed to help instructors integrate the characteristics of hypermedia and the Internet into instruction. Learning from the program, learners could synthesize information and build constructive knowledge of digital logic design.

The program will have the following benefits over traditional teaching methods:

- provide learners an interactive environment to manipulate the knowledge and information;
- allow learners to navigate the global logic related knowledge domain;
- allow learners to be inquisitive and explore the domain of digital logic;
- promote learners to connect prior knowledge to final knowledge;
- allow learners learning by self pace;
- encourage learners to take the efficient path to master learning.

Based on the features of the learning environment, the following pedagogical goals will be achieved:

- understand the logical operation ofthe standard digital components;
- embed design skills in practical contexts;
- integrate the basic logic concepts into related applications;
- encourage self-awareness of the knowledge construction process;
- encourage learn-teacher interaction in the learning process;
- encourage collaborated learning between peers.

3.2 The Framework of Concept Mapping

In the learning environment, the global concept map consisting of a number of nodes, as shown in Figure 1, is woven with the complete frame of digital logic design. The learner can acquire the definition of the concept and the related information on each node. The first level of this concept map includes five key concepts (data representation, digital IC, logic gates, combinational logic circuits, and sequential bgic circuits) have to be covered in the subject matter. In addition to these topics, the goal of this course, and the differences between digital and analog are also shown on the map.

At the sublevels, there are a variety of submaps interconnected either "vertically" or "horizontally" to the related nodes. These nodes comprise demonstration, tutorials, simulations and questions to help learners understand digital logic concepts. For example, the flip-flops node is linked to a simulation program [8], which presents the internal operations of the four types of flip-flops (RS, JK, D, and T). In the program, learners can select any type of the flip-flops and assign the inputs, then by simulating the dynamic behavior between the internal gate chains to observe the operation of the circuit.

Figure 2 is the type of a subconcept map. It represents the map of multiplexers, which supports the core concepts of multiplexers in order that learners can yield good understanding on the multiplexer topic. Learning from the map, learners can understand the basic concepts (truth tables, logic diagrams and logic symbols) and the relations among the concepts. In addition, the six examples of application provide a meaningful way to learn the details of multiplexers in digital systems. The node of the related web sites

provides an opportunity to access more references about multiplexer applications, which usually cannot be acquired from the textbook or from the lab.

This environment offers many equally appropriate paths to the learners. Depending on the learner' s interest and available time, he can look at one or many concepts addressing one or more topics. Each concept stands alone, but offers hyperlinks to related topics. A concept map provides easy reference to the concepts that are to be presented in all topics; this makes it possible to better organize the contents for any given module or submodules. The module concept maps are cross-referencing of key ideas, and offer the intrinsic meaning in each module. Thus, learners could acquire vivid mental images.

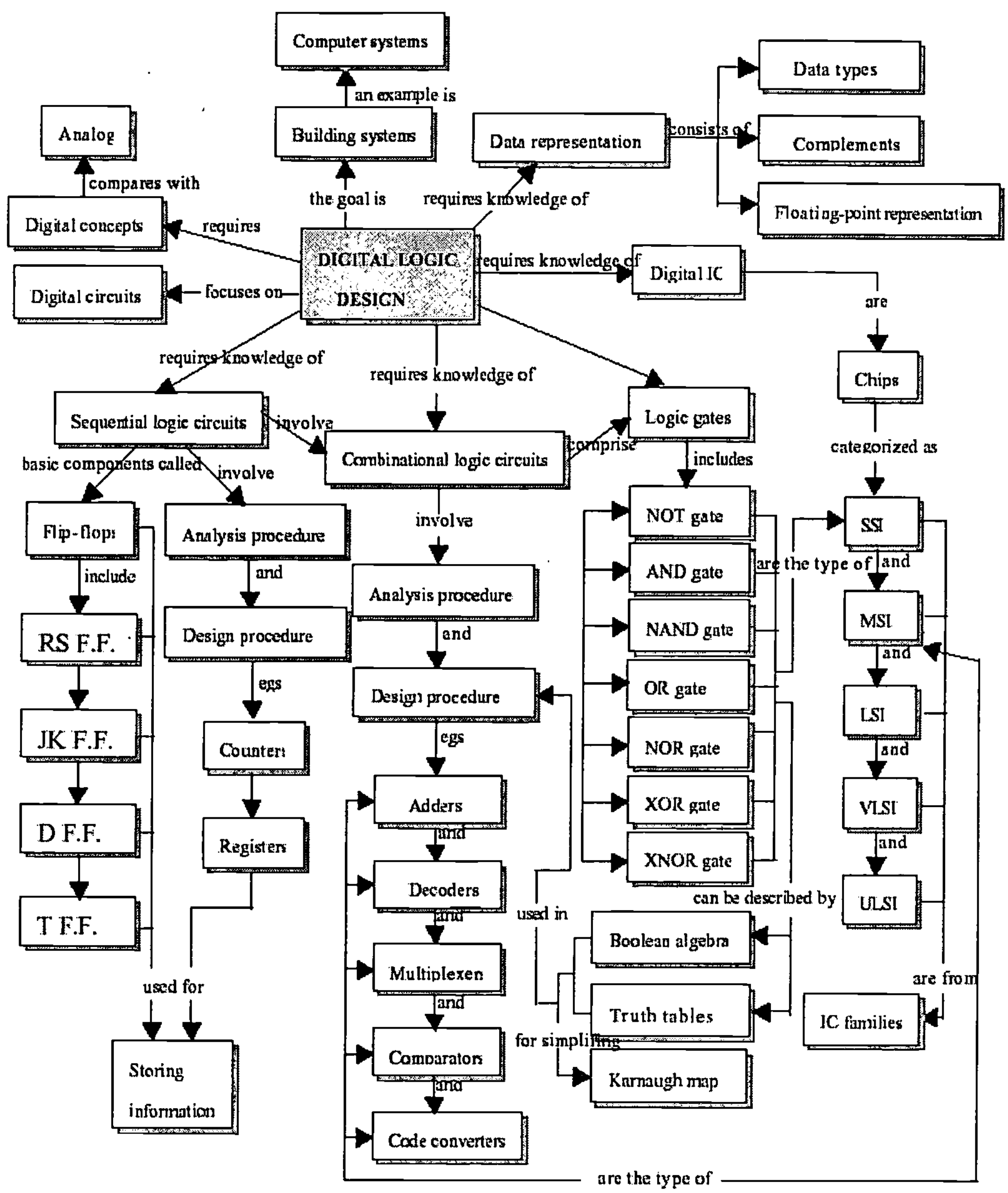


Figure 1. The concept map of digital logic design

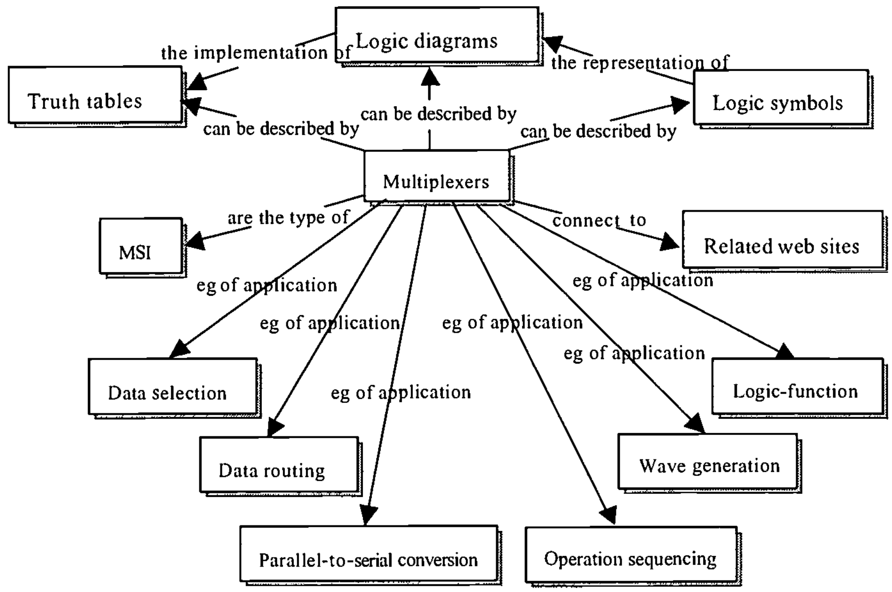


Figure 2. The concept map of multiplexers

4 Summary

In today's classrooms, learning emphasis should not be on rote memorization but on the ability to access information in many ways. We cannot assume that the self-directed nature of learning processes by concept mapping will increase learning results. Instead, concept mapping may be viewed as a better approach to complement and supplement the learners' learning processes.

It is expected that concept mapping, as described in this paper, is more promising than other relationship schemes for both teaching and learning. More research is needed on this issue; this paper approaches the issue as stimulation.

References

[1] Alexander, J. O. (1999). Collaboration design, constructvist learning, infomation technology immersion, &
electronic communities: A case study. Interpersonal Computing and Technology: An Electronic Journal for the 21st Century, 7(1-2). URL: http://jan.ucc.nay.edu/~ipct-j/1999/n1-2/alexander.html.
[2] Barenholz, H., & Tamir, P. (1992). A comprehensive use of concept mapping in design instruction and assessment. Research in Science and Technological Education, 10(1), 37-52.
[3] Clarke, J. H. (1990). Patterns of thinking. Needham Heights, MA: Allyn and Bacon.
[4] Hill, J., & Buerger, B. (1996). Hypermedia as a bridge between education and profession. Educational Technology Review, 5, 21-25.
[5] Horton, P. B., McConney, A. A., Gallo, M., Woods, A. L., Senn, G. J., & Hamelin, D. (1993). An investigation of the effectiveness of concept mapping as an instructional tool. Science Education, 77(1), 95-111.
[6] Kommmers. P., & Lanzing, J. (1997). Students' concept mapping for Hypermedia design: Navigation through World Wide Web space and self-assessment. Journal of Interactive Learning Research, 8(3/4), 421-455.
[7] Lee, P. M., & Sullivan, W. G. (1996). Developing and implementing interactive multimedia in education. IEEE Transactions on Education, 39(3), 430-435.
[8] Lin, H. M. (1999). A computer simulation program for enhancing the concepts of sequential logic. Proc.

of
ED-MEDIA 99, p.1704. June. Seattle, Washington, U.S.A.
[9] Novak, J. D., & Gowin, D. B. (1984). Learning how to learn. New York: Cambridge University Press.
[10] Rautama, E., Sutinen, E., & Tarhio, J. (1997). Supporting learning process with concept map scripts. Journal of Interactive Learning Research, 8(3/4), 407- 420.
[11] Roberts, L. (1999). Using concept maps to measure statistical understanding. International Journal of Mathematical Education in Science and Technology, 30(5), 707-717.
[12] Turing, M., Hannemann, J., & Haake, J. (1995). Hypermedia and cognition: Designing for comprehension.
Communications of the ACM, 38, 57-66.
[13] Wallace, J. D. (1990). The concept map as a research tool: Exploring conceptual change in biology. Journal of Research in Science Teaching, 27(10), 1033-1052.

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.

Online Education: A Learner-Centered Model with Constructivism

Kam Hou VAT
Faculty of Science & Technology
University of Macau, Macau
fstkhv@umac.mo

This paper describes the initiative to construct a WWW-enabled course and project support environment for undergraduate education, aimed to uphold the constructivist's ideas of active learning. The system is intended to create learning experiences that invite students to construct knowledge and to make meaning of their worlds of learning. In particular, we discuss the educational framework of our design through the Problem-Based Learning (PBL) approach, from the perspectives of the architect of the intellect. We also describe the incremental prototyping process of software development, through scenarios of participatory design of our students in Software Engineering at the author's affiliated faculty. The paper concludes by discussing the challenge of implementing the fully functioning constructivist WWW-based environment through blending the art and science of teaching into creative cognitive designs.

Keywords: **Constructivism, Problem-Based Learning (PBL), Learner-Centered Philosophy**

1 Introduction

With the advent of the World Wide Web (WWW or Web) towards the end of the 20th Century, the use of this Internet-based hypermedia technology in education has become the trend of today. The Web is aimed to facilitate learning in different disciplines, and is becoming the major driver to construct numerous experimental Web-based support environment in campuses around the globe. However, online education in the form of Web-based instructions (WBI) or Web-enabled learning environment, without an anchoring philosophy of education, could easily become a technology-rich educational wasteland. The theme of this paper is to investigate how the insights of our educational visionaries [5] could be designed into our Web-based support environment, to suit the unique schemata of individual learners. Actually, such designs require rigor in identifying certain essential elements of the constructivist architecture. And they represent challenges to the learning in our daily classrooms, which has typically involved having students repeat newly presented information on tests or in reports. Constructivist teaching practices help learners internalize, or transform new information, which in turn makes further understanding possible. Therefore, as instructional designers, the guiding question in tackling our Web-based design is this: How do we create a technology-enhanced learning environment that engages students in the types of activities that will take on their initiative and responsibility for their own learning?

2 Project Background

In the spring of 1999, a group of junior students in Software Engineering, initiated an informal study group (ISG) [15] with the author's facilitation. The ISG's mission is to help students develop their team-based technical interest in preparation for their graduation project. And we started exploring the ongoing development of Web-based distributed applications with online education as one of our first discussion topics. During the discussion, the author, as an instructor, expressed his difficulties in traditional classroom setting, to recognize students' intellectual and motivational problems, to explain to them a difficult part of the subject matter, to provide clear tasks, and to coach students in specific problem-solving activities. These issues indeed go far beyond the classroom walls. As students, they expressed their need for a learner-centered atmosphere whose focus is put on the needs, skills, and interests of the learners, and whose goal is

to encourage active exploration and construction in the course of learning activity. Likewise, we developed the initial idea of creating an environment where anyone is free to learn, to construct and refine new meaning in one' s own learning, and to have enough channels to ask for help, when necessary, in the form of some extended service of a good teacher. We continue our expedition into Web-based technology to turn out the project ideas of creating a) a course support environment for active learning, and b) a project support environment for problem-based learning (PBL). The former has been given the project name **REAL** [13] to imply a Rich Environment for Active Learning, while the latter, **SUPER** [14] to denote SUitable and Practical Educational Resources for group-based project work. And in either project, we have not ruled out the familiar face-to-face classroom interactions between teacher and students, as one of the essential aspects of the learning process.

3 Pedagogical Intakes

In selecting the pedagogy of our Web-based environment, we have borrowed from the legacies of our educational visionaries in blending the art and science of constructivist teaching. John Dewey' s designs embedded learning in experience [3]. He advocated field studies and immersion in experiences to stimulate learning. Jean Piaget' s work influences constructivist educators through designs of discovery learning [9]. Students manipulate subject matter and objects representing the subject matter as they interpret their findings. He believed that learners' internalization leads to structural changes in how they think about something as they assimilate incoming data. Today, constructing meaning on the basis of one' s interpretation of data is the heart of science inquiry, problem-based learning models, and case studies. Lev Vygotsky' s theory [16] suggests that we learn first through person-to-person interactions and then individually through an internalization process that leads to deep understanding. This belief in the social process of idea making permeates today' s interactive classroom led by skillful teacher questioning. Reuven Feuerstein' s mediated learning theory [4] refutes the concept of an unchanging intelligent quotient (IQ) and leads to intense examination of how the classroom affects students' metacognition. He believes that the discovery process requires intervention from the teacher to guide learning. On examining the varied work of the master architects, and trying to crystallize the essential elements of the constructivist architecture, we see an array of tools emerging. They include a learner-centered curriculum; enriched environments; interactive settings; differentiated instruction; inquiry, experimentation, and investigation; mediation and facilitation; and metacognitive reflection.

4 Instructional Design

We expect the instructional design of our Web-based support should increase student participation and communication through re-designing the delivery of college lectures to incorporate more student online activities and instructor' s feedback before, during and after the contact session. The environment is expected to develop students' abilities to generate problems, to engage in collaboration, to appreciate multiple perspectives, to evaluate and to actively use knowledge. From the designers' standpoint, we have included the following enabling ideas:

a) *Enable students to determine what they need to learn through questioning and goal setting.* It is believed that students should work to identify their knowledge and skill deficits, and to develop strategies in the form of personal learning goals for meeting those deficits. The emphasis is to foster a sense of students' ownership in the learning process. If teachers, through the Web-based support environment, can guide the students in identifying what they already know and what they need to learn, then knowledge gaps and mistakes can be viewed in a positive way such as another opportunity to learn. And students can assume more responsibility in addressing their own learning needs during any instructional unit.

b) *Enable students to manage their own learning activities.* It is believed that students should be enabled to develop their learning plans, which should describe priorities, instructional tactics, resources, deadlines, roles in collaborative learning situations, and proposed learning outcomes, including presentation and dissemination of new knowledge and skills, if applicable. Traditionally, these instructional events are arranged by teachers to be obeyed by students, in order to accomplish a specified set of pre-determined objectives. Yet, it is not advantageous for students to learn to be self-directed. To manage their own learning activities, students must be guided and supported by the teacher, through the Web-based environment, slowly taking on more and more responsibility of their own learning.

c) *Enable students to contribute to one another's learning through collaborative activities.* It is believed that

students should be encouraged and supported to discuss and share their personal findings. Particularly, we should enable students to become co-builders of the course/learning resources through evaluating and refining the entries their peers put into the Web-based depository. Collaborative group-based learning seems appealing to achieve the purpose. Students, nevertheless, must be educated to recognize what they are trying to learn in group-work, value it, and wish to share that value with others. Teachers can provide this sense of accountability and belonging by structuring students' work in the support environment with such concept as computer-supported cooperative work (CSCW).

It is convinced that the efficacy of the learning environment is a function of many complex factors, including curriculum, instructional methodology, student motivation, and students' developmental readiness. Trying to capture this complexity onto the design of our Web-based environment, is more an ongoing iterative process than a one-time activity. So we develop scenarios of situated learning support applicable to both individual course taking and group-based project work. These scenario-based supports are then incorporated into the environment incrementally, subject to our students' participatory testing.

5 Scenario-Based Support

Imagine attending a class where the instructor, after giving an introduction of what the course is entailed, invites you to visit his/her course support environment on the Web. On entering the Web-based environment, you are offered the privilege of creating your own personal space in the form of a customizable Web page guarded by your self-assigned identifier and password. Within your personal Web space, you are furnished with some tools to start your Web-life. These include a communications facility to keep one another in touch (email and newsgroup); a calendar planner to track your appointments or commitments (meetings or homework due dates, or project deadlines); and a frequently-asked-questions (FAQ) tool to send for instructor's help when encountering difficulty in housekeeping the personal space. Also, there are pathways to other service modules:

a) Course Information. This module provides such information as the course description, pre-requisite requirements, evaluation policy, references list, and other details such as time and location of the lectures. It also includes links to the instructor's contact details, his/her teaching/research profile, and the course schedule showing timetable for class with links to the study materials before, during and after contact sessions. Also included is the announcement service representing the most up-to-date information sent to the students from the instructor.

b) Course Resources. This module comprises the study materials prepared by the instructors, and the contributions representing students' submitted or reported work of interest to other students. Study materials can further be cataloged and managed as different resources: study notes, tutorial handouts, supplementary lecture details, or Web-links in the Internet. It could also include FAQs of the course: homework, quiz's, tests, examinations, and projects.

c) Course Assessment. This module keeps track of students' performance. The score each student obtained after completing a specific activity is recorded with enough details for evaluation at the end of the course. Students are encouraged to propose their own study plan to earn the accumulated score required, to complete the course. This service is designed into the Learning Contract [7] component to individualize the learning process for any individual learner. Typically, a student is required to write a formal agreement, which details what will be learned, how the learning will be accomplished, the period of time involved, and the specific evaluation criteria to be used in judging the completion of the learning.

d) Course Inquiry. This module fulfills several requirements of the teacher-student inquiry interaction. These include: a) a sense of dedicated space for an extended collaboration between teacher and student; b) an incremental delivery of inquiry results from teacher to student; and c) visibility of the inquiry interactions to avoid duplicating effort, and to encourage discovery of related interests. When an inquiry is initiated by a student, a request Web page is generated which is specific to that interaction and to which the teacher and student return frequently for their interaction. This request Web page (meeting space on the Web), contains the relevant material required for the specific inquiry interaction, say, contact details of the student and the teacher in the form of Web links or email addresses. Each request Web page supports several types of interaction: posting comments, recording actions, uploading/downloading files. These can be carried out at any time in any order. This feature is designed to support the often-time extended discussion and incremental result delivery of the teacher-student collaboration. Also, since the completed

request Web page could be visible to any registered student or teaching staff within the Faculty intranet, this increases the general awareness of the teacher's activities in consulting students, and avoids duplicating efforts of other staff in dealing with similar questions from students. More importantly, when users browse the inquiry activities over the Web, they are always exposed to information as to who was involved in what, and eventually they will learn about one another's specialties and interests. Hopefully, they will form communities centered about specific knowledge and interest; such are considered as important assets of any educational institute.

Now, on visiting the Web-based support environment and reading the latest announcement for the next lesson, you are aware that the next lesson is about group-based project work. According to the instructor's message, group project work is an essential component of any academic degree; many professional societies worldwide emphasize project and group work as preparation for professional practice. Also, you are to follow the problem-based learning (PBL) approach to work in teams. And you will be introduced to the teaming process and the PBL support of the Web-based environment.

6 Problem-Based Learning (PBL)

It is understood that project work is recognized as having many educational and social benefits, in particular providing students with opportunities for active learning. However, teaching, directing and managing group project work is not an easy process. This is because projects are often: *expensive* demanding considerable supervision and technical resources; and *complex* combining design, human communication, human-computer interaction, and technology to satisfy objectives ranging from consolidation of technical skills through provoking insight into organizational practice, teamwork and professional issues, to inculcating academic discipline and presentation skills. In preparing our students to get started with group-based project work, we have oriented towards the PBL learning model. According to the literature [1, 2], the modern history of PBL began in the early 1970s at the medical school at McMaster University in Canada, and ever since, PBL has been adopted in various fields such as Teaching, Engineering and Management.

6.1 PBL Pedagogy

The PBL approach focuses education around a set of realistic, intrinsically motivating problems to fit the interests and needs of the learners. It acknowledges the possibility of prior knowledge held by the learner. Further knowledge is acquired on a 'need to know' basis, enabling the learner to diagnose one's own learning needs. Knowledge gained is fed back into the problem in an iterative loop, allowing the synthesis of topics and know-how [10]. When applied to the course setting, PBL should encourage students' active participation, and develop in them self-directed learning and problem-solving skills while they interact, discuss and share relevant knowledge and experience. More importantly, PBL revolves around a focal problem, group work, feedback, class discussion, skill development and final reporting. The instructor's role is to organize and pilot this cycle of activity, guiding, probing and supporting students' initiatives along the way so as to empower them to be responsible in their own learning.

6.2 PBL Activities

Students, on being presented with a problem or scenario, are made aware that initially they will not possess enough prior information to solve the problem at hand or to clarify the scenario immediately. These problems are often ill-structured, but devised according to concrete, open-ended situations. They are reminded that they must identify, locate, and use appropriate resources, and ask questions referred to as "learning issues" on the various aspects of the problem. These learning issues should help them realize what knowledge they require to construct a solution, and thus focus their learning efforts and establish a means for integrating the information they acquire. Often, they are encouraged to perceive themselves as managers of their own in terms of time, material resources, and the complexity of the problems that can be handled one at a time by the group. It is expected that the PBL students have to iterate through some relevant stages of activities: analysis, research, and reporting, with discussion and feedback from peers and the instructor at each stage.

• *Analysis.* Throughout this stage, students organize their ideas and prior knowledge related to the problem, and start defining its requirements. This helps them devise a specific statement of the problem. Meanwhile, they are encouraged to pose learning issues, defining what they know and what they do not know. This helps them assign responsibilities for research, eliciting and activating their existing knowledge as a crucial step in

learning new information.

• *Research.* Throughout this stage, students collect necessary information on specific learning issues raised by the group. They may conduct library searches, seek sources on the Internet, collect data, and interview knowledgeable authorities. More importantly, students teach themselves as they research their learning issues. It is intended that when they come to realize the complexity and texture of the problem, they may often see that information is a means to the ends of managing problems effectively.

• *Reporting.* At this stage, students report their findings to the group. Individual students become "experts" and teach one another. Subsequently, their discussion may generate a possible solution, or new learning issues for the group to explore further. Final solutions are constructed, and the facilitator' s feedback should help students clarify basic information, focus their investigations, and refine their problem-solving strategies, besides addressing whether the original learning issues were resolved and whether the students' understanding of the basic principles, information, and relationships is sufficiently deep and accurate.

6.3 PBL Teamwork Experience

It is important that PBL students are taught how to work in teams and positively experience the team process because the team skills they acquire are applicable throughout their future careers. The PBL team process requires each team composed of 3-5 students, to be assigned a supervisor (instructor) and a client if applicable. The client' s role is to clarify the project, and to resolve ambiguities as they arise, whereas the supervisor' s is to guide, motivate and provide feedback to the team. Also, one of the team members is designated the team leader for the duration of the project, whose role is to coordinate the team activities, and to ensure effective team communications. The leader also has to interface with the supervisor, arrange meetings with clients when necessary, and facilitate meeting through setting agendas, taking minutes, and allocating tasks. Each team member has to help set the team goals, accomplish tasks assigned, meet deadlines, attend team meetings and take a turn editing a document to be submitted at the end of each major stage of project development.

Meanwhile, PBL students are made aware of the difficulties in teamwork throughout the project period. These include setting realistic project goals, carefully allocating tasks to team members, managing time, and communicating and managing shared group documents. Teams have regular meetings to which they invite their supervisor, and in which they organize themselves to manage the project. Students are often reminded of setting appropriate agendas before meeting, assigning enough time to the agenda items during meeting, restating the decisions made at the meeting, and converting decisions into action items after meeting. They are also advised on clearly separating the social and work aspects in meetings, and assessing each meeting for doing it better next time. Moreover, it is suggested that teams plan their project around major deadlines of individuals in the team thereby acknowledging the other commitments team members may involve.

Deadlines represent the milestones set down for the PBL students to submit project documents and to receive evaluation. Each team member is assessed by their supervisor and their team peers. The supervisor' s evaluation is based on what each team member adds to the meetings and what the instructor perceives each member' s contributions to the team to be. The peers' evaluation is based on a confidential rating sheet, to be completed by each team member at the end of each major phase of the project. This rating sheet should include each team member' s contribution for that phase with explanatory comments. And the overall project assessment is made up of the group grade and the individual grade. The former is the same for each group member and is based on the quality of the documents produced and the product developed. The individual component is based on the quality of the student' s contribution to the documents and the product, their participation in group-meetings, their commitment to the team process, and their professional attitude developed.

7 Scenario-Based PBL Support

Imagine you have just attended the second lesson on PBL and group project work. And you realize that the PBL support available in the Web comprises both the learning and performance aspects. These are actually a series of strategies and Web-based solutions that use instructional design principles to improve students' work-based performance according to the real-life PBL activities. And you are invited to visit the PBL-specific Web site to register as a PBL-user. The registration process invites you to fill in a Web form including a simple questionnaire for teaming purpose. You are now allowed to enter the PBL-support environment with your PBL identifier and personal password returned after the registration.

And for exploratory purpose, you have just navigated to the PBL Web page for the Software Engineering course *SFTW 300 Software Psychology* (Figure 1). Here you are presented with a number of projects to express your preferences to join through filling in another Web form activated by clicking the link "Join a Team" in the same page. You can then find out which team and project have actually been associated with you by clicking the link "Identify Your Team" also in the same page. On knowing which project to engage, you could click the suitable PBL Space link, i.e., "S300F99P3" in this case, to navigate to the suitable PBL Space (Figure 2). The PBL Space is assigned for each PBL group for project management on the Web. It contains links to the project itself, the PBL Group (including its members' links), the PBL Client, and the PBL Supervisor. Each of such links is associated with a set of related links for information and support of the project. Among the numerous support links in the PBL Group, you can find the *Work Space* link, which leads to the "Group Work Space" (Figure 3) Web page. This page contains links to individual group members and to specific PBL support, as well as to the project interim progress. Clicking on the individual member's link (PWS) leads to the "Personal Work Space" (Figure 4), where each group member's progress in terms of PBL activities (analysis, research, reporting, implementation) is tracked.

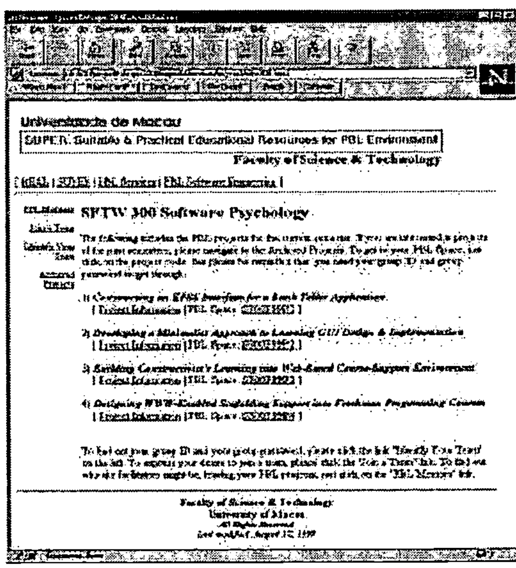


Figure 1: PBL Web Page for SFTW 300

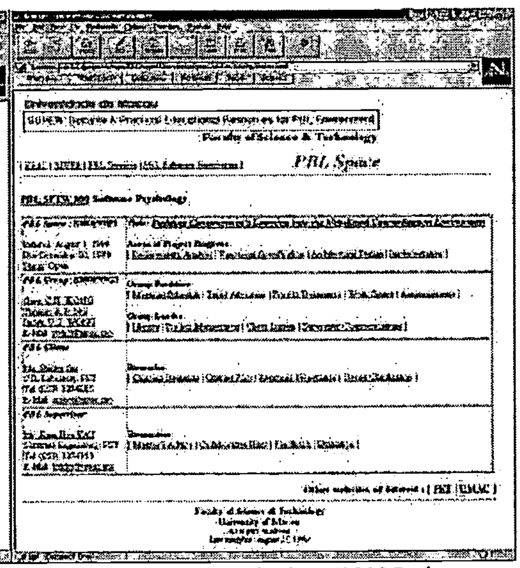


Figure 2: PBL Space for SFTW 300 Project

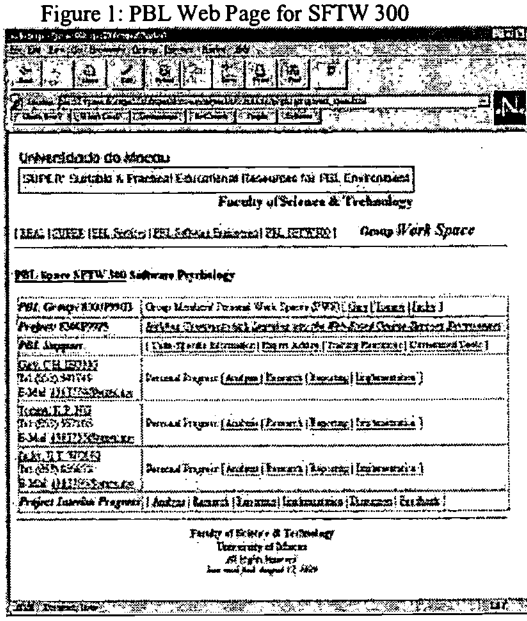


Figure 3: Group Work Space for a SFTW 300 Project

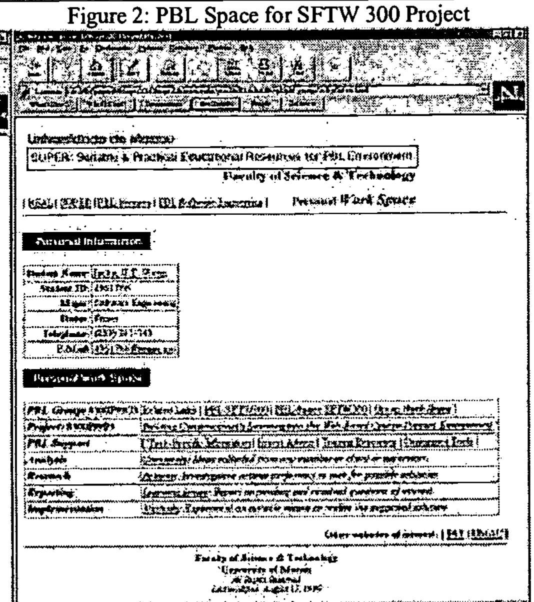


Figure 4: Personal Work Space for a SFTW 300 Project

8 Software Development

Our database-driven Web-based support environment has been developed as a series of distributed applications, by employing a mixture of object-orientation, client/server, and Internet (Web browsers, Web servers – HTML, HTTP, FTP) technologies, to deliver the desired support functionality. Such applications are largely event-driven because of the intensive graphical user interface (GUI) programming (e.g., handling the points and clicks) and/or because of the message exchanged between clients and servers over the Web. The specific types of individual Web applications constructed can be categorized into such classes as: a) static HTML-based, b) server-side (CGI-based) and c) client-side (Java-based or JavaScript-based). And the major steps followed to develop the distributed applications could be abstracted as follows:

a) *Analysis.* Establish users' requirements of what information are needed by whom and when, in terms of functionality, performance, security, operability, and management of the distributed applications. And develop an object model that shows conceptually how the information will be organized, accessed, manipulated, and presented in terms of objects.
b) *Architecture.* Partition the architecture concerns into: *data architecture*, determining what data sources (HTML, files, databases) will be needed, where they will be located, and how they will be accessed; *software architecture*, determining what will be written as CGI/Java code, what will be constructed as modules called by CGI/Java, where will the various objects/modules reside, and how they will be invoked (CORBA, RPC); *infrastructure architecture*, determining the servers where the home pages and the objects/modules will reside, the type of gateways that will be employed, the type of middleware that will be needed to invoke remote services and objects (CORBA, ActiveX, RPC, SQL), and the type of computing platforms (PC Windows, UNIX, Linux, Windows NT) used.
c) Implementation and Deployment. Build the HTML pages (including the Java-powered pages) by coding HTML or using filters that generate HTML from other data sources (e.g. Word documents). Then develop and test the software modules and objects. If necessary, purchase the appropriate infrastructure components. Fourth, test, install and deploy the system, followed by maintenance and the iterative re-design process.

9 Prototyping Process

The Web-based support in our online environment is developed incrementally through a user-driven iterative prototyping process, which involves our instructional designers, teachers, and students in the participatory development. This involves creating a series of function prototypes used to clarify the objectives of the system in light of design exploration between the designer and the users (teachers and students), so that the users gradually understand what can be achieved with the technology. Our knowledge of requirements, design and implementation may be incomplete in any one cycle; however, there has been progressive build-up of a structure, which will lead to the desirable system. Specifically, we have referred to the Dynamic Systems Development Method (DSDM) [12] for project guidance, which walks us through four main phases of the DSDM life cycle.

The *feasibility study* phase is to define the high level functional requirements of the environment, which refer to the educational support issues. This phase should produce an outline prototyping plan and establish the main non-functional requirements, such as the hardware and software to develop and deliver the system. The *functional prototype iterations* phase is to clarify the detailed requirements for the system. Its output includes a series of prototypes that demonstrate the main system functionality. These early visual prototypes are mainly used to clarify the system objectives between the designers and users. The *design prototype iterations* phase is to refine the functional prototype into a robust product after a more situated evaluation of system requirements. It involves satisfying all the non-functional requirements; i.e., producing a system that will work effectively on the target hardware in the organizational setting. It is understood that all the possible components of the system do not have to be developed in unison. Some may move on to the design and build phase while others are still at the functional clarification stage. The *implementation* phase involves placing the system in the user environment, carrying out any required training, reviewing the system and assessing further developments. The output should include a delivered system, user manuals/training, and project review document.

10 Conclusion

It is experienced that the conventional approach to education remains the instructivist one, in which knowledge is perceived to flow from experts to novices. This transmissive view of learning is most evident in the emphasis on lectures, in the use of textbooks to prescribe reading, and in the nature of tutorials and assessment methods. It assumes that the process of good teaching is one of simplification of the truth in order to reduce student confusion. Yet, this simplification could deny students the opportunity to apply their learning to dynamic situations. We question the transferability of the instructivist learning and ask how much of that which is assigned to academic learning ever gets applied to actual scenarios, when there is such a rapid surge in knowledge commonly associated with the birth of the "Information Age." This is a transference problem. Actually, the content product of learning is assuming a less important role relative to the process of learning as the life of information content shortens and the need for continual learning increases. In designing the Web-based support of our learner-centered environment, we have tried to reoriented towards a meaningful direction by reducing the obsession with knowledge reproduction. And PBL represents one such relief from the constructivist pedagogy. Greening [6] describes it as a vehicle for encouraging student ownership of the learning environment. There is an emphasis on contextualization of the learning scenario, providing a basis for later transference, and learning is accompanied by reflection as an important meta-cognitive exercise. Also, the implementation of PBL is done via group-based work, reflecting the constructivist focus on the value of negotiated meaning. Besides, it is unconfined by discipline boundaries, encouraging an integrative approach to learning, which is based on requirements of the problem as perceived by the learners themselves.

Undeniably, constructivism is a philosophy of learning that is having a major effect on the way that education is conducted today. In this paper, we have tried to spell out the working characteristics of constructivism [11], which have actively shaped the design of our Web-based support. These include: 1) Meaning is not transmitted. Instead, learning occurs as a process of adjustment of existing concepts. 2) Understanding is based on interaction among a complex weave of factors, such as the learners' goals and existing concepts, the content of the learning experience, the context where the learning occurs. 3) Puzzlement motivates learning. This sense of dissatisfaction emerges from experiences that threaten existing conceptual structures. 4) Social negotiation and viability are the principle forces involved in the evolution of knowledge. They ensure that learning is anchored both by the learning community and by the need to test constructions against reality. The effects of such testing are the adjustments in the structure of concepts held by the learner. So, one thing is evident: constructivist learning experiences can exert high cognitive demands on learners [8], and not all learners could respond well to the challenge. We believe the constructivist ideas assembled here make up what we might call pragmatic constructivism. Namely, constructivism could be viewed as a toolbox for problems of learning. If a particular approach does not solve the problem, try another. In keeping with this flexibility, active, social and creative learning can play out in rather different ways, depending on the circumstances. Although the term constructivism suggests a single philosophy and a unique potent method, there is not such thing as a one-size-fit-all. Rather, our suggestion is to look at constructivism like a Swiss knife with various blades for various needs. That is also the learner-centered philosophy behind our Web-based support for online education.

References

[1] Albanese, M., and Mitchell, S., " Problem-Based Learning: A Review of Literature on Its Outcomes and Implementation Issues," Academic Medicine, Vol. 68, No. 1, 1993, pp. 52-81.
[2] Barrows, H., " How to Design a Problem-Based Curriculum for the Pre-Clinical Years," New York: Springer, 1985.
[3] Dewey, J., " Experience and Education," New York: Macmillan, 1938.
[4] Feuerstein, R., " Instrumental Enrichment: An Intervention Program for Cognitive Modifiability," Baltimore: University Park Press, 1980.
[5] Fogarty, R., " Architects of the Intellect," Educational Leadership, Vol. 57, No. 3, 1999, pp.76-78.
[6] Greening, T., " Scaffolding for Success in Problem-Based Learning," Medical Education Online, 3(4) 1998, pp.1-15. http://www.utmb.edu/meo/
[7] O'Donnell, J.M., and Caffarella, R.S., "Learning Contracts," In M.W. Galbraith (Ed.), Adult Learning Methods. Malabar, Florida: Krieger Publishing Company, 1990, pp. 133-160.
[8] Perkins, D.N., "What constructivism demands of the learners?" In T.M. Duffy & D.H. Jonassen (Eds.), Constructivism and the Technology of Instruction: A Conversation (pp. 161-165). Hillsdale, NJ:

Erlbaum 1992.
[9] Piaget, J., "Piaget's Theory," In P. Mussen (Ed.), Carmichael's Manual of Child Psychology. New York: Wiley, 1970.
[10] Ryan, G., "Student Perceptions about Self-directed Learning in a Professional Course Implementing Problem-Based Learning," Studies in Higher Education, Vol. 18, 1993, pp. 53-63.
[11] Savery, J.R., and Duffy, T.M., " Problem-Based Learning: An Instructional Model and its Constructivist Framework," Educational Technology, 35(5) 1995, pp. 31-38.
[12] Stapleton, J., "DSDM: Dynamic Systems Development Method – The Method in Practice.," Addison Wesley, 1997.
[13] Vat, K.H., "REAL: Towards a WWW-Enabled Course Support Environment for Active Learning," Faculty Technical Report, FST/SE-1999-01, University of Macau, Macau.
[14] Vat, K.H., "SUPER: Towards a WWW-Enabled PBL Support Environment for Software Engineering Education," Faculty Technical Report, FST/SE-1999-02, University of Macau, Macau.
[15] Vat, K.H., "Training E-Commerce Support Personnel for Enterprises through Action Learning," In Proceedings of the 2000 ACM SIGCPR Conference, Chicago, Illinois, USA, Apr. 6-8, 2000, pp.39-44.
[16] Vygotsky, L.S., "Mind in Society: The Development of Higher Psychological Processes," Cambridge, MA: Harvard University Press, 1978.

Schema Theory-based Instructional Design of Asynchronous Web-based Language Courses

C. Candace Chou
Interdisciplinary PhD Program in Communication and Information Sciences
University of Hawaii
Email: chou@hawaii.edu

Instructional design (ID) provides a framework to facilitate both teaching and learning activities. ID also prescribes desirable learning outcomes. This paper introduces the implementation of an ID template in web-based language courses. The ID template incorporates several cognitive strategies based on schema theory. A schema-theory-based model provides a useful framework for knowledge organization and information processing. In a course that emphasizes reading comprehension, schema theory accounts for how learners construct meaning from texts based on the information they encounter, the prior knowledge they already have, and the way they interact with the new information. The ID template consists of four instructional sequences. The cognitive strategies, ID examples, and purposes for each sequence are illustrated. The sequences include warm-up activities, preparatory activities, core activities, and post activities. Each sequence is interconnected with the others and looped back to the beginning in each lesson unit. The preliminary evaluation results indicate the degree of student satisfaction for the ID template for various external and internal factors.

Keywords: **instructional design, schema theory, cognitive strategies, web-based foreign language instruction**

1 Introduction

Instructional design (ID) plays a critical role in the success of distance education. ID is an interdisciplinary science that provides a theoretical background for the design and implementation of instructional units to achieve desirable learning outcomes. ID principles encompass theories in both learning and instruction. Although the instructional design for web-based instruction does share some common principles with instructional design for traditional classroom teaching, the modes of instruction and learning are quite different from each other. The roles of learners and instructors continue to go through fundamental changes as well. What kind of instructional theories can be best applied to web-based education? There is no one single universal theory for all instructional design as the objectives, learning contexts, subject matters, and expected learning outcomes vary from one field to another. The development of ID also depends on the pedagogical principles that the instructors or instructional designers adapt to. The views on instructional design can be approached from different perspectives such as behavioral (Gropper, 1983); systematic (Gagne, Briggs, & Wager, 1992); structural (Scandura, 1983); motivational (Keller, 1983), transactional (Merrill, 1997); and cognitive (Tennyson, 1990; West et al., 1991). Cognitive schema theory especially receives prominent attention in the field of instructional design and language education for its emphasis on the use of aid for perception, learning, comprehension, and recall (Anderson, 1984; West et al., 1991). This paper focuses on the application of schema theory to the instructional design of language courses delivered through the World Wide Web. The preliminary evaluation results are summarized at the end.

2 Theoretical Framework

Why is ID important in web-based distance education? Reigeluth (1983) argued that ID is a linking science between theory and practice. This linking science was further elaborated by Tennyson and Schott (1997): "As a field of study, it provides a theoretical foundation to principles of instructional design, a research base confirming the theoretical foundations, and a direct involvement in the application of those principles" (p. 1). ID theories prescribe the variables and conditions required for certain learning outcomes. Furthermore, the practice of ID utilizes various methods and technologies to develop learning environments based on these theories (Tennyson & Schott, 1997). Many ID models have been developed and the theoretical bases vary greatly. A typical model includes the following five steps: "(1) setting the *objectives;* (2) *preassessment*, that is, determining whether the target students have the prerequisites to benefit from the instruction; (3) *planning the instruction*; (4) *trial*, that is, presenting the instruction for developmental purposes; and (5) *testing* and *evaluation*" (West et al., 1991). Each step can be further divided into more detailed instructional sequences. The focus of this paper is on planning the instruction based on cognitive learning theories. Schema theory is an especially appropriate cognitive learning theory because of its emphasis on knowledge organization and representation.

There is no one single theory called schema theory. It has evolved and become the basic component of many cognitive learning theories. According to cognitive theorists, schemas or schemata are mental data structures that represent our knowledge about objects, situations, events, self, sequences of actions and natural categories (Anderson, 1985; Rumelhart, 1981). Schemata are also like scripts of plays (Schank & Abelson, 1977). In other words, schemata are chunks of knowledge stored in the human mind by patterns, structures, and scaffolds (West et al., 1991). Based on Rumelhart's definition (1981), schemata serve the function of "scaffolding." Knowledge is perceived, encoded, stored, and retrieved according to the chunk of information stored in the memory. Schemata facilitate information processing. Schema can be "instantiated" by specific examples of concepts or events. For example, one's schema for "teaching" can be instantiated by viewing a scenario on the interaction between a teacher and students. As soon as schemata are instantiated, one can associate or recall more similar scenarios (Bruning et al, 1995). Schema theory is appropriate for language instruction due to its powerful explanation of memory and recall. In the case of reading comprehension, schema theory accounts how learners construct meaning from texts based on the information they encounter, the prior knowledge they already hold, and the way they interact with the new information (Bruning et al, 1995, p. 275). As summarized by Andre (1987), schemata serve the following important function in reading comprehension:

1. Providing the knowledge base for assimilating new text information
2. Guiding the ways readers allocate their attention to different parts of reading passages
3. Allowing readers to make inferences about text materials
4. Facilitating organized searches of memory
5. Enhancing editing and summarizing content
6. Permitting the reconstruction of content (Bruning et al., 1995, p. 275).

Schemata provide the backgrounds for learners to comprehend a text by inference. Schemata also make it possible to summarize a passage by selecting the parts that are important to them. These processes cannot be completed without the knowledge structures that schemata provide. Since one of the elements of schema theory is making predictions based on what learners already know, making the link between the old information and the new information has generated a great deal of research interest. Two areas of research in this direction are advance organizer and schema activation.

Advance organizers employ the structure of some materials that the learners are already familiar with as the framework of the new materials. In other words, advance organizers are designed to offer "ideational scaffolding for the stable incorporation and retention of the more detailed and differentiated material that follows" (Ausubel, 1968, p. 148). Advance organizers are relevant introductory materials that are introduced in advance of the core texts. Recent studies have also shown that providing short and concrete examples for upcoming events are more useful to readers than abstract, general, and vague learner organizers (Corkill et al., 1988).

Schema activation refers to the design of activities for the purposes of activating learner's knowledge in

similar fields prior to learning new subject matters (Bruning et al., 1995). They are often in the forms of short questions. In a way, schema activation serves similar purposes of advanced organizers by linking new information with old information that the learners already know. However, schema activation relies more on the learners to generate information from their previous knowledge base. Schema activation works better if the schema activating activities are relevant to the to-be-learned information. A study on the reading comprehension of a group of fifth-graders showed that the group with relevant schema activation remembered the reading texts better than the groups with non-relevant schema activation (Peeck et al., 1982).

There are also many other cognitive strategies that help students with reading comprehension. These strategies are designed to help students in gaining control of their learning process for the purpose of comprehending reading texts. Bruning et al. (1995) summarized the following five strategies for reading comprehension:

1. *Determining importance:* Instructional activities can be designed to help learners locating the main ideas of the text. Without knowing the main ideas, readers would have a hard time understanding the text.
2. *Summarizing information:* Students should not only learn to summarize the main ideas in a passage but also generate a text that represents the original one. Students' reading skills improve when their summarization skills improve.
3. *Drawing inferences:* Studies have shown that the ability to make inferences is positively associate with reading skills (Dewitz et al., 1987; Raphael & McKinney, 1983). Good readers are usually good at guesswork.
4. *Generating questions:* Good readers ask questions frequently. Through self-questioning or peer-exchanged questions, learners will have a better understanding of texts.
5. *Monitoring comprehension:* Readers should have the ability of knowing when they understand the text and when they do not. A good reader also has the ability to detect errors and inconsistencies in the reading materials. When they become critical of the reading texts, they do a better job in detecting errors. Peer editing or peer-critiquing is a good way to monitor comprehension (Bruning et. al., 1995, p. 279-284).

The next section describes how some of the cognitive strategies can be employed in the instructional design of web-based language courses.

3 Instructional Design Template for Web-based Language Courses

The web course introduced in this paper is the first one in a series of Asian language courses using the same instructional design templates. There is a lack of higher-level language courses (3rd year and above) in Less Commonly Taught Languages (LCTLs) such as Asian languages and other non-Roman languages in American universities and colleges. Yet, the need for higher-level language courses does exist for students who would like to continue language studies. The objectives of the web courses are to provide opportunities for students whose institutes do not provide language courses in LCTLs and to disseminate information on the ID model of pedagogically sound language instruction. The first course that is currently offered through the University of Hawaii systems is a Chinese reading and writing course at the 3rd and 4th year level. A Chinese listening/reading/writing course and a Korean reading/writing course will be offered in fall 2000. More courses in Japanese and other LCTLs are in the planning stage at present. The instructional design template is summarized as follow:

Goal: To improve Chinese reading and writing skills.

Objectives:

1. Students will possess the skills to decipher reading materials through a series of cognitive strategies.
2. Students will improve writing skills through continuous revisions, peer-critique, and teacher feedback.
3. Students will have a good command of vocabulary in the subject matters covered in the course.
4. Students will co-construct knowledge together through collaborative tasks in building word bank, grammar clinic, and essay database.

Content: The content covers a wide variety of topics based on authentic teaching materials collected from China and Taiwan, including topics such as cuisine, travel, medicine, celebrities, university, and so on. These materials were developed into ten self-directed reading lessons on a CD-ROM. The web course uses the CD-ROM as the core reading materials. Each web lesson unit was designed to enhance the understanding of the equivalent core text in the CD-ROM.

Format of the Instruction: The World Wide Web and the CD-ROM were selected to deliver the instruction and course content. Asynchronous communication via email and web-forum are the means for student-student and student-teacher interactions.

Table 1 Instruction design template for web-based language courses

ID Sequence & Modules	Cognitive Strategies	ID Examples	Purposes
1. Warm-up activities	Schema activation	Word bank	Brainstorming on terminology Co-construction of knowledge base
2. Preparatory activities	Advance organizer	Picture matching	Preparation for forthcoming texts
3.1 Core activities	Determining importance Drawing inferences	Working on CD-ROM reading activities	Determining the importance of information
3.2 Core activities	Generating questions	Q&A	Self-questioning
3.3 Core activities	Scaffolding	Small Group Discussions	Debate/Discussion/Role Play Use input for other activities
3.4 Core activities	Monitoring comprehension	Grammar Clinic	Peer editing with teacher feedback
4.1 Post activities	Modeling	Sample essay	Teacher demonstration
4.2 Post activities	Recall	Language work	Monitoring comprehension
4.3 Post activities	Summarizing information	Composition & revision	Individual output with collective database on writing samples

Sequence of Instruction: The framework of the instruction sequence is adapted from Hiple and Fleming's (1996) work which is specifically designed for foreign language instruction. The ID examples are developed by the instructors Fleming & Lu (1999) for web-based language courses. There are eight units in each web course. Each unit employs the following four sequences of instruction.

1. *Warm-up activities:* These activities employ simple and short questions to activate learners' previous knowledge relevant to the subject matter. For example, on the unit for cuisine, students are asked to write down two or three things they know about Chinese cooking. Their responses are put into a database called the "word bank." By the end of each unit, students have accumulated an abundant collection of glossary under a specific language topic.
2. *Preparatory activities*: Students are asked to match some descriptions with pictures. These pictures provide a background information of the lesson and prepare the students for the forthcoming texts.
3. *Core Activities*: There are four components in Core Activities: working on the CD-ROM, Q & A forum, Small Group Discussions, and Grammar Clinic. Students first go through the reading activities in the CD-ROM. They then post questions about the content of the CD-ROM on the Q & A web forum. Following that, they are divided into three-member or two-member small groups to carry out a conversational task. Take the cuisine unit for example, they have to make up their minds on which restaurant to go to for dinner. One conversation example is provided so that students know in advance the scope and depth of the expected conversation. In Grammar Clinic, the instructors pick several erroneous sentences from the Small Group Discussions and post them

at the Grammar Clinic (a web forum) for peer editing and critiquing. All these sentences are posted anonymously.

4. *Post Activities*: In the final stage the learners model from teacher's examples and peers' writings before they work on their own essays independently. First, the teacher provides a sample essay and a language matching exercise to reinforce the key words in the essay. Gradually, teachers withdraw help and let the student compose their own essays. If they have a hard time starting, they can view other students' submissions of essays in the database to come up with more ideas.

Among the eight units, the last two units are designed for language exchange with native speakers from the country of the target language. For more details, please refer to the web site (http://www.lll.hawaii.edu/yuedu). The ID template can be modified for different language instruction. The Word Wide Web is an especially perfect media since all information is recorded and saved in the database. Students can always go back to review the collective database for their own review.

4 Evaluation of the web course

In the evaluation process, the instructional design team is interested in student feedback on the sequences of instruction. At the end of each unit, students are asked to fill out an anonymous feedback form that consists of 10 questions on a five-point Likert scale. Comment areas are provided for each question. Table 2 shows the preliminary partial results on the ID template evaluation.

Students had provided valuable feedback to the instructional design team. The team was able to use this feedback to adjust course content and activity design. Generally speaking, students agreed that most instructional design modules are useful for their learning. The degree of helpfulness varies from module to module. However, it seems that the students generally did not like the use of the CD-ROM. One reason is that the CD-ROM could only be used on a Macintosh while 95% of the students in the class used PC-compatible computers. PC users were restricted to use campus Macintosh computers to access the content in the CD-ROM. Furthermore, since the CD-ROM was developed for self-directed learning, there was also a lack of interaction between students and teachers. Finally, there were some bugs in the programming of the CD-ROM. Students were not enthusiastic about the programming bugs. The team is in the process of converting the CD-ROM into cross-platform media and fixing the bugs.

Table 2 Feedback on Instructional Design Lesson Template

1 = Strongly disagree; 2 = Disagree; 3 = Slightly Agree; 4 = Agree; and 5 = Strongly Agree		Unit 2 (mean)	Unit 4 (mean)	Unit5 (mean)	Unit7 (mean)
	Post Unit feedback questions	(n=11)	(n=9)	(n=11)	(n=9)
Q1	I have gained new knowledge from this unit.	4.09	3.78	3.73	3.56
Q2	When I ask for help, the instructors respond in a timely way.	4.45	4.33	4.09	3.33
Q3	When I ask questions, the instructors give me the answers I need.	4.36	4.33	4.09	3.67
Q4	The warm-up activities are useful. (i.e. contributing and sharing vocabulary)	3.73	3.78	3.73	3.44
Q5	The preparatory activities are useful. (i.e. matching pictures to text)	3.91	3.67	3.36	3.22
Q6	The content of the core lessons (CD-ROM) is well designed.	3.18	3.33	2.91	NA*
Q7	The forum discussions (i.e. Q&A, role-play, small group discussion) are useful.	4.09	3.78	3.73	3.33
Q8	The grammar clinic is helpful	3.45	3.89	3.73	NA*
Q9	The language work is at the proper level of difficulty.	4	4.00	3.55	3.56
Q10	The essay writing is at the proper level of difficulty.	4.09	4.22	4.09	3.67
	Average	3.94	3.91	3.701	3.473

* Unit 7 is designed for language exchange. The questions on CD-ROM and Grammar Clinic are not applicable.

As for the web-based instructional modules, the warm-up activities were not deemed as useful as the instructional design team had expected them to be. When monitoring student online activities through the server-tracking program, it was found that most of them did not go back to use the database after submitting

the required entries. The instructor started requiring the students to incorporate the vocabulary into their essays towards the end of the semester. By then, it may have been too late to see how the change in instructional strategy would affect the way the students utilize the database. This is a good lesson for instructional designers. All instructional sequence should be interconnected and continuously looped back to the beginning. If the instructional modules are designed as stand-along units, students will not see the purpose of building on the knowledge based that they have co-constructed.

Finally, there seems to be a slight decline in the helpfulness of the ID modules when comparing the average in table 2. The perceived helpfulness declines especially in unit 7. The change in instructional format (i.e., language exchange) and the more specialized topic (i.e., movies) may have posed a greater challenge for less competent students. Interviews with the student may help to find out the real reasons. Nevertheless, the comments from students were overall positive. Here are a few comments from the students.

" The warm-up activities have been very helpful in preparing for the entire lesson."

"The preparatory activities makes one think harder about the subject material."

"Small group discussion wasn't as interesting as the previous units because there were a little interactions among students."

" I believe I would not have learned all of the new words from a textbook. Contributing and sharing vocabulary for this unit has really helped my ability to read the Chinese newspaper's entertainment section."

"The text for this section was presented in a way that forced me to focus and analyze more fully the meaning. A good challenge which I enjoyed."

" This unit helped me to learn unique vocabulary for discussions with almost any Chinese speaker. I am more confident that I can carry a conversation with a Chinese speaker about my favorite movie."

"While on occasion some vocabulary has been a little bit difficult, once I put the sentence or paragraph into context, the usage of the vocabulary became more clear."

5 Conclusions

ID sets up a framework for desirable learning outcomes. The incorporation of cognitive strategies helps students to efficiently achieve the learning objectives. It can be found from their comments that the students valued greatly the aspects of online interaction and co-construction of a knowledge database. It is through the collaborative tasks that they are able to interact for a purpose, i.e., for the completion of a task that has a real-world application. The overall ID objectives have been met through the instructional sequences. Nevertheless, there is not much evidence supporting the effectiveness of the ID modules other than students' own remarks. Further study on the comparison of the actual online activities (e.g. tracking the mouse clicks) with their perceptions on the usefulness of each ID module can provide more insight into the effectiveness of the instructional design. In addition, an objective panel of language experts to evaluate the performance of the students could also provide assessment to the final learning outcomes.

References

[1] Anderson, R. C. (1984). Role of reader's schema in comprehension, learning, and memory. In R. C.
[2] Anderson, J. Osborn, & R. J. Tierney (Eds.), *Learning to read in American schools: Basal readers and content texts*. Hillsdale, NJ: Lawrence Erlbaum Associates.
[3] Anderson, R. C. (1985). *Cognitive psychology and its implications*. New York, NY: Freeman.
[4] Andre, T. (1987). Questions and learning from reading. *Questioning Exchange, 1*, 47-86.

at the Grammar Clinic (a web forum) for peer editing and critiquing. All these sentences are posted anonymously.

4. *Post Activities*: In the final stage the learners model from teacher's examples and peers' writings before they work on their own essays independently. First, the teacher provides a sample essay and a language matching exercise to reinforce the key words in the essay. Gradually, teachers withdraw help and let the student compose their own essays. If they have a hard time starting, they can view other students' submissions of essays in the database to come up with more ideas.

Among the eight units, the last two units are designed for language exchange with native speakers from the country of the target language. For more details, please refer to the web site (http://www.lll.hawaii.edu/yuedu). The ID template can be modified for different language instruction. The Word Wide Web is an especially perfect media since all information is recorded and saved in the database. Students can always go back to review the collective database for their own review.

4 Evaluation of the web course

In the evaluation process, the instructional design team is interested in student feedback on the sequences of instruction. At the end of each unit, students are asked to fill out an anonymous feedback form that consists of 10 questions on a five-point Likert scale. Comment areas are provided for each question. Table 2 shows the preliminary partial results on the ID template evaluation.

Students had provided valuable feedback to the instructional design team. The team was able to use this feedback to adjust course content and activity design. Generally speaking, students agreed that most instructional design modules are useful for their learning. The degree of helpfulness varies from module to module. However, it seems that the students generally did not like the use of the CD-ROM. One reason is that the CD-ROM could only be used on a Macintosh while 95% of the students in the class used PC-compatible computers. PC users were restricted to use campus Macintosh computers to access the content in the CD-ROM. Furthermore, since the CD-ROM was developed for self-directed learning, there was also a lack of interaction between students and teachers. Finally, there were some bugs in the programming of the CD-ROM. Students were not enthusiastic about the programming bugs. The team is in the process of converting the CD-ROM into cross-platform media and fixing the bugs.

Table 2 Feedback on Instructional Design Lesson Template

1 = Strongly disagree; 2 = Disagree; 3 = Slightly Agree; 4 = Agree; and 5 = Strongly Agree		Unit 2 (mean)	Unit 4 (mean)	Unit5 (mean)	Unit7 (mean)
	Post Unit feedback questions	(n=11)	(n=9)	(n=11)	(n=9)
Q1	I have gained new knowledge from this unit.	4.09	3.78	3.73	3.56
Q2	When I ask for help, the instructors respond in a timely way.	4.45	4.33	4.09	3.33
Q3	When I ask questions, the instructors give me the answers I need.	4.36	4.33	4.09	3.67
Q4	The warm-up activities are useful. (i.e. contributing and sharing vocabulary)	3.73	3.78	3.73	3.44
Q5	The preparatory activities are useful. (i.e. matching pictures to text)	3.91	3.67	3.36	3.22
Q6	The content of the core lessons (CD-ROM) is well designed.	3.18	3.33	2.91	NA*
Q7	The forum discussions (i.e. Q&A, role-play, small group discussion) are useful.	4.09	3.78	3.73	3.33
Q8	The grammar clinic is helpful.	3.45	3.89	3.73	NA*
Q9	The language work is at the proper level of difficulty.	4	4.00	3.55	3.56
Q10	The essay writing is at the proper level of difficulty.	4.09	4.22	4.09	3.67
	Average	3.94	3.91	3.701	3.473

* Unit 7 is designed for language exchange. The questions on CD-ROM and Grammar Clinic are not applicable.

As for the web-based instructional modules, the warm-up activities were not deemed as useful as the instructional design team had expected them to be. When monitoring student online activities through the server-tracking program, it was found that most of them did not go back to use the database after submitting

the required entries. The instructor started requiring the students to incorporate the vocabulary into their essays towards the end of the semester. By then, it may have been too late to see how the change in instructional strategy would affect the way the students utilize the database. This is a good lesson for instructional designers. All instructional sequence should be interconnected and continuously looped back to the beginning. If the instructional modules are designed as stand-along units, students will not see the purpose of building on the knowledge based that they have co-constructed.

Finally, there seems to be a slight decline in the helpfulness of the ID modules when comparing the average in table 2. The perceived helpfulness declines especially in unit 7. The change in instructional format (i.e., language exchange) and the more specialized topic (i.e., movies) may have posed a greater challenge for less competent students. Interviews with the student may help to find out the real reasons. Nevertheless, the comments from students were overall positive. Here are a few comments from the students.

" The warm-up activities have been very helpful in preparing for the entire lesson."

"The preparatory activities makes one think harder about the subject material."

"Small group discussion wasn't as interesting as the previous units because there were a little interactions among students."

" I believe I would not have learned all of the new words from a textbook. Contributing and sharing vocabulary for this unit has really helped my ability to read the Chinese newspaper's entertainment section."

"The text for this section was presented in a way that forced me to focus and analyze more fully the meaning. A good challenge which I enjoyed."

" This unit helped me to learn unique vocabulary for discussions with almost any Chinese speaker. I am more confident that I can carry a conversation with a Chinese speaker about my favorite movie."

"While on occasion some vocabulary has been a little bit difficult, once I put the sentence or paragraph into context, the usage of the vocabulary became more clear."

5 Conclusions

ID sets up a framework for desirable learning outcomes. The incorporation of cognitive strategies helps students to efficiently achieve the learning objectives. It can be found from their comments that the students valued greatly the aspects of online interaction and co-construction of a knowledge database. It is through the collaborative tasks that they are able to interact for a purpose, i.e., for the completion of a task that has a real-world application. The overall ID objectives have been met through the instructional sequences. Nevertheless, there is not much evidence supporting the effectiveness of the ID modules other than students' own remarks. Further study on the comparison of the actual online activities (e.g. tracking the mouse clicks) with their perceptions on the usefulness of each ID module can provide more insight into the effectiveness of the instructional design. In addition, an objective panel of language experts to evaluate the performance of the students could also provide assessment to the final learning outcomes.

References

[1] Anderson, R. C. (1984). Role of reader's schema in comprehension, learning, and memory. In R. C.

[2] Anderson, J. Osborn, & R. J. Tierney (Eds.), *Learning to read in American schools: Basal readers and content texts*. Hillsdale, NJ: Lawrence Erlbaum Associates.

[3] Anderson, R. C. (1985). *Cognitive psychology and its implications*. New York, NY: Freeman.

[4] Andre, T. (1987). Questions and learning from reading. *Questioning Exchange, 1*, 47-86.

[5] Ausubel, D. P. (1968). *Educational psychology: A cognitive view.* New York, NY: Holt, Rinehart and Winston.

[6] Bourdeau, J., & Bates, A. (1997). Instructional design for distance learning. In S. Dijkstra, N. Seel, F. Schott, & R. Tennyson (Eds.), *Instructional design international perspective: Solving instructional design problems* (Vol. 2, pp. 369-397). Mahwah, NJ: Lawrence Erlbaum Associates.

[7] Bruning, R. H., Schraw, G. J., & Ronning, R. R. (1995). *Cognitive psychology and instruction.* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

[8] Corkill, A. J., Bruning, R. H., & Glover, J. A. (1988). Advance organizers: Concrete vs. abstract. *Journal of Educational Research, 82*, 76-81.

[9] Dewitz, R., Carr, E. M., & Patberg, J. P. (1987). Effects of inference training on comprehension and comprehension monitoring. *Reading Research Quarterly, 22*, 99-119.

[10] Fleming, S., & Lu, J.-Y. (1999). *CHN399a: Chinese Reading and Writing Course.* Available: http://www.lll.hawaii.edu/yuedu.

[11] Gagne, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of instructional design.* (4th ed.). Fort Worth: TX: Harcourt Brace.

[12] Gropper, G. L. (1983). A behavioral approach to instructional prescription. In C. M. Reigeluth (Ed.), *Instructional-design theories and models* (pp. 101-161). Hillsdale, NJ: Lawrence Erlbaum Associates.

[13] Hiple, D., & Fleming, S. (1996). *Stages of a receptive skill lesson development.* Available: http://www.lll.hawaii.edu/workshops/chinesenet/lessons/stages.html.

[14] Keller, J. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 383-437). Hillsdale, NJ: Lawrence Erlbaum Associates.

[15] Merrill, M. D. (1997). Instructional transaction theory: An instructional design model based on knowledge objects. In R. D. Tennyson, F. Schott, N. Seel, & S. Dijkstra (Eds.), *Instructional design international perspective: Theory, Research, and Models* (Vol. 1). Mahwah, NJ: Lawrence Erlbaum Associates.

[16] Peeck, J., Bosch, V. D., & Kruepeling, W. (1982). The effect of mobilizing prior knowledge on learning from text. *Journal of Educational Psychology, 74*, 771-777.

[17] Raphael, T. E., & McKinney, J. (1983). An examination of fifth- and eighth-grade children's question answering behavior: An instruction study in metacognition. *Journal of Reading Behavior, 15*, 67-86.

[18] Reigeluth, C. M. (1983). *Instructional-design theories and models: An overview of their current status.* Hillsdale, NJ: Lawrence Erlbaum Associates.

[19] Rumelhart, D. E. (1981). Schemata: The building blocks of cognition. In J. T. Guthrie (Ed.), *Comprehension and teaching: Research reviews* (pp. 3-26). Newark, DE: International Reading Association.

[20] Scandura, J. M. (1983). Instructional strategies based on the structural learning theory. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 383-437). Hillsdale, NJ: Lawrence Erlbaum Associates.

[21] Schank, R. C., & Abelson, R. (1977). *Scripts, plans, goals, and understanding.* Hillsdale, NJ: Lawrence Erlbaum Associates.

[22] Tennyson, R. D. (1990). Integrated instructional design theory: Advancements from cognitive science and instructional technology. *Educational Technology, 30*(8), 14-21.

[23] West, C., Farmer, j., & Wolff, P. (1991). *Instructional design: Implications from cognitive science.* Englewood Cliffs, NJ: Prentice Hall.

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]).

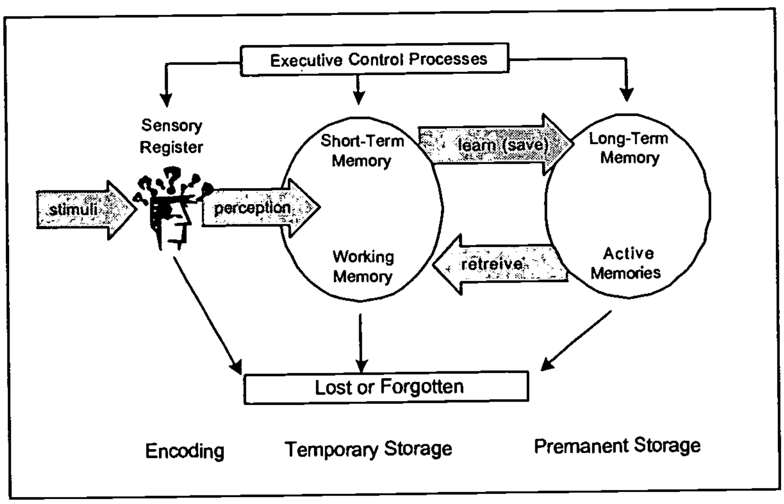


Figure 1 – The Information Processing Model

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).

The Application of Scaffolding Theory on the Elemental School Acid –Basic Chemistry Web

***Zangyuan Own, Kai-Pein Wong**
Department of Applied Chemistry, Providence University
#200, Chun-Chi Road, Shalu, Taichung, Taiwan 433
Tel: +886-4-6329216
Fax: +886-4-6327554
E-mail:zyown@pu.edu.tw

The knowledge of chemistry is base on the realization of fact and experiments, students must try to infer, experiment and realize deeply to achieve the goal of highly efficient learning. Base on the scaffolding theory, we have designed a three- tier client-server web title which is a distributional database formats about the chemistry subject-"Acid and Base chemistry" for elemental school students. We use a lot of multimedia animation and Internet techniques to create a scaffolding environment make students learn it instantly and mutually. It turn out that all the students have excellent improvement learning outcomes. All the experts, the interaction designing experts, the network experts, software designers and primary school teachers gave a positive affirmation about the web title; the teaching content and the interaction design are all get the very positive confirmation. The result of learning effect is very convention; the statistical analysis shows that all learners who entered this web site made a great progress in their knowledge test. Besides, ANOVA statistical analysis shows that this scaffolding chemistry web site made a great help for L type learners. Learners' previous science knowledge has nothing to do with the study effect.

Keywords: **Scaffolding Theory• •Acid-Base Chemistry• •Web Title and Learning Effect**

1 Introduction

Because of the shortage of real experience and the misconception of teaching content, traditional teaching cannot inform the students about the concepts which teachers want to deliver. With the development of the Internet, the form of education is shifted from teacher center to the learner center. The future of science teaching is base on the new nine-year consistent project, it is important to integrate the Internet as a major tool to enforce this project. All of these will help improve the quality in elemental chemistry education for our children.

2 Motive and purpose

In these coming years, internet was the major domain of research academics and government officials. In the 1990s Internet software took giant leaps forward in usability. The biggest change came with the development of the World Wide Web (WWW), a vast tract of the Internet accessible to just about anyone who could point to buttons on a computer screen. It led the Internet's transformation from a text-only environment into a multimedia landscape incorporating pictures, animation, sounds, and even video.

The teaching by the Internet exceeds the traditional passive one-way learning, but stresses on interaction. Taking the advantage of instant pass by the Internet, you can browse through all kinds of fascinating information sources and discover worlds of knowledge. We create a web page about the chemical

experiments- the acid and base in nature environment. By the global of networks, we can easily transform the information by character, animation and video. The different learning effect which associated with different learning style students, different ages, different sex and different previous knowledge of science may cause the different learning out come.

3 Theory background

The scaffolding theory brought up by a Russian psychologist (L. S. Vygotsky). He sustains students with the scaffolding techniques through out his teaching process. In the beginning of the scaffolding, it would be a process from other-regulation develops to social negotiation. In teaching, the teacher will design a temporary supporting constructions thought out the whole lecture, which help the learner to develop his learning ability. It is called scaffolding. There are two important subjects within the scaffolding theory. There are communication and cognition, the function of social cognition is to make the learners improve his abilities in solution and self-examination, and students certainly be promoted by the active learning styles.

Scaffolding instruction means that the teacher can help the learner make the most of their potential. Under scaffolding instruction, student will join the learning activity positively instead of remaining passive. Thus, an individual would have his own cognition framework.

There would be six important principles about the instruction.

1.In the real teaching activity, the teacher is the scaffolding maker for the learner.
2.The supporting degree is dependent on the standard of the learners; there would be a modification.
3.The more the ability of the learner increases, the less the support decreases.
4.The support is in proportion to the standard of the activity.
5.The suppor will be modified gradually and at any time. Then it would keep on.
6.Make the learner independent.

In the learning effect, many scholars announce their research results. They would analyzed what kind of the learner is and then decide to create the appropriate on-line instruction web page. Different learning-styled students in CAI(Computer-assisted instruction) would have different learning effects in various feedback.

The feedback is composed of the following four parts:
No feedback. (2) Knowledge of results feedback. (3) Informative feedback. (4) Informative feedback in personal language.

According to the research results by the scholars Dori and Yohim(1990), students in proper sequence may have highly-efficient learning effects. On the contrary, learning by leaping ways was low efficient learning effect. The former is called L type, and the latter is called W type. It means that different learning style may cause various learning effects to students.

The learning ways of students are classified into Super-L, L, W and Super-W type. There are large parts of high school students with L type in particular. The second position is W type. The L type (straight-line) means students follow the learning materials and never change the route. The W type means students don't follow the learning materials and change the route all the time. The Super-W type means that students may play out the entire learning process. It has a strong relation between the learning style and the logical thinking talent.

4 The Research Method

System Installation

The research is base on a web title course, it is a Three-Tier Client-Server sets. Most browsers accepted this kind of device. Server can share responsibility for the management to the request of client. It can transform the information from the database by the request of the client, then the client will process the information it got from the server.

To achieve harmony with education, the government has computerized all elemental schools, but the

schools have not been equipped with highly-performance computer. Microsoft bring up an idea of thin client. A computer with modem and browser can use this system. To have a better web title designed, we got the type called 3-Tier (Figure 1). It bases on the platform of Windows NT 4.0 Server SP6. We created the Web Server with Microsoft Internet Information Server 4.0. As a result of dealing with the users' get-in information, we use the MS-SQL 7.0 Server system as a platform for database.

In the process of making the web site, we use a computer with Pentium III 450 processor, which is associated with Front page 2000 to design all the required homepages. And we use the common draft tools (Adobe Photoshop and Macromedia Flash) to deal with pictures and make them more interactive. Finally, we use the SPSS statistics system to analyze the results of learning effect.

The part of system interface, we use ASP(Active Sever Page) to design the interface, and take the advantage of Visual C^{++} to create a stable and efficient web page in the core part .

5 The Research Object

Our research is aimed at the students in Grade Six of elemental school. The design for course content

We take a lot of real household materials, which is concern about acid and base as teaching examples. Such as the lemon• Clorox and vinegar. The nature of soap water is slippery. If you wet your clothes carelessly with sulfuric acid• hydrochloric acid or sodium hydroxide, the clothes would be damaged. And they will scorch the skin. There would be the calculation of the PH. The definition of acid and base is on the produced amount of H^+ and OH^-.

The vinegar is composed of five percent of acetic acid. The molecular formula of acetic acid is written as CH_3COOH. The one hundred percent of acetic acid is called icy acetic acid. The reason why a lemon has acidity is that it is composed of lemon acid.

In the laboratory, the ammonia NH_3 is a base. It is because it produces a lot of OH^- in water. The ammonium ion is acid. It is composed of H^+. At the normal temperature, the HCl is gaseous state. It is a acid. The carbonic acid H_2CO_3, Sulfuric acid H_2SO_4, boric acid is all acids. There are common base such as sodium hydroxide NaOH and calcium hydroxide $Ca(OH)_2$. Sodium bicarbonate $NaHCO_3$ is a base; it has a common name called baking soda. People with much hydrochloric acid in gastric juice may take some medicine composed of magnesium hydroxide to neutralize.

The experts and scholars suggest that we should create a interactive web page of scaffolding theory should base on the acid-base knowledge map which is created at beginning of the course. The another major frame is an on-line discussion section. Initially we would have some general questions about acid & base, which the students have to find out their own solutions. If their answer is correct, then they can enter another subject, otherwise they have to keep on finding the answers. In the process of learning, students may have an efficient learning freedom by the active video program we provide with in the web page.

The content of the web
1.Question-learning function induce students to learn.2.Question of situation in our daily life.3.A simple operation interface.4.To stress on vision and hearing.5.Guided learning then learning control.

There are twelve units in the teaching material, which is a scaffolding design.
1.Litmus paper. 2.The nature of liquid.3.The definition of alkaline-liquid operation.4.The definition of acidic-liquid operation.5.The definition of neutral-liquid operation.6.The reaction between alkaline and acidic liquid.7.The neutralization of acid and alkali.8.The application of neutralization of acid and alkali.9.The nature of acid and alkali.10.The nature of sodium hydroxide.11.The advanced concept of acid.12.The advanced concept of alkali.

Most of elemental school students cannot understand the nature of acid and base. So we classify the course into two parts, which may happen in real life and in the textbook. We ask the student to register as they entering the studying web page. And let them brow though the entire house, which have five areas (kitchen, bathroom, living room, backyard and bedroom), all fill of the brand name items. The computer will record the pass way of learner, which then will be analysis to learning style (W-type or L-type). If the learner follow every step of the computer, they will have 10 points, which is classify as L-type, if the learner did not

follow the step which computer direct, they will deduct 2 point for each time, the points lower than 3, it is classify as W-type. The acid-base lecture is designed base on scaffolding theory. The system would determine when to removes the scaffolding setup or not by the amount of the correct analysis of computer generated data and suggestion by the experts and the scholars. After a serious study, this system is set up to remove the scaffolding structure when students scored seventy percent of designed questions. Before the system removes the scaffolding structure, the on-line instructor is standing by the side to help them solve some difficult problems. It's so-called on line ICQ.

For example, if students ask what the hydrochloric acid is by the on line ICQ. The instructor will pub out and tell the student that it's a kind of corrosive solution, which is used to clean your bathroom

The hydrochloric acid also exists in our stomach; it helps us in the digest. You can clean the lavatories in the schools or in our home with it, too. And all of these questions and answers will be put into Acess database as a Q&A databank for future use.

If the scaffolding has been removed, a discussion section will appear on the screen. Students can ask any question or play the teacher part to answer questions. We can save lots of the teaching resource in the way.

All the pretest and posttest questions are substrate from ACS (American Chemical Society) test bank, which is careful designed and tested for, determine chemistry knowledge of students.

6 Result and Discussion.

From January 10 to March 10 we have selected 221 students to analyze. And the result of analysis is as follow (table 1):

Table 1. The analytic table about the learning style

Category	Amount	Average	Standard varies
Boy	118	5.65	1.13
Girl	103	5.81	2.08
Whole	221	5.72	1.57

Research Sample

There are 221 students enter our web site for learning acid and base concepts, base on their data collected, we picked up forty learners (twenty are L-type, twenty are W-type) as our study samples. L-type (Boys >7.78, Girls>7.89) and W-type (Boys < 3.52, Girls<2.73)

Evaluate the Web Site

We invited five elemental school science teachers, five teaching scholars, five software designers, and ten elemental school students to evaluate the web site. The average results are in table 2.

Table 2. Statistic of evaluation result

Item	Software designers	Teaching scholars	Elemental teachers	Elemental students
Homepage design	4.50(90%)	4.50(90%)	3.75(75%)	4.50(90%)
Teaching material	3.75(75%)	4.25(85%)	4.75(90%)	4.10(83%)
Interface	4.30(86%)	3.90(78%)	3.60(85%)	4.70(94%)
Whole style	4.25(85%)	4.25(85%)	4.50(90%)	4.50(95%)

In the aspect of homepage design, elemental schoolteachers gave us lower points (3.75). They thought that instructional contents should be more intensive, and the relation knowledge should increase to enrich our web site. The software designers thought that the homepage should be more vivid than previous to stress the topics.

In the aspect of teaching material, some students complain that contents are not obvious, and we should introduce topics clearly.

In the aspect of interface, the teaching scholars and software designers thought that the operation should be familiar with users. In the meanwhile, they generally praised us in animation, and encouraged us used more.

At whole aspect, they all thought that web base learning indeed archiving the instruction targets.
Learning Effect

After tested, all eighty students had been improved in their acid & base knowledge. The overall improved score average is 18.15. L-type learners average improved 23.35, and W-type learners average improved 12.95 (table 3). It is obvious that our web site have much help in learning acid-base chemistry.

Table 3. The statistics of achievement test

L-type	Pretest	Posttest	Improved	W-type	Pretest	Posttest	Improved
Average	55.80	79.15	23.35	Average	51.75	64.70	12.95

We used the SPSS statistics software running data to analysis the deviation. The P value of learning style relation to score of pretest is 0.063, which is greater than 0.05, indicated that the learning style has no relationship to the pretest score. (table 4)

Table 4. Deviation analysis of different learning style relate to pretest score

Deviation source	Degree of free	Average square root	F	P
Learning style	1	529.256	3.499	0.063
Inaccuracy	158	151.258		
Total	159			

The P value of learning style relation to the score of posttest was 0.015, which was smaller than 0.05. It indicate that posttest score was relation to learning style, which means that L-type learning style improved remarkable. (table 5)

Table 5. Deviation analysis of different learning style relate to posttest score

Deviation source	Degree of free	Average square root	F	P
Learning style	1	1829.256	5.993	0.015
Inaccuracy	158	305.240		
Total	159			

7 Conclusion

Instruction by Internet is the better way in teaching chemistry at present day. According to our research, we have three conclusions:

1. After using the web site, the learners all had improved their test score remarkably. It shows that it is a better learning process for students to study acid-base chemistry in the elemental school.
2. The P value of learning style relation to posttest score was 0.015, which was smaller than 0.05. It shows that L-type learner had positive progressed in using scaffolding web site.
3. After the experts evaluated the web title, this acid-base chemistry web indeed bringing on-line instruction into full play. This web site's design style could be a very good example for the future science web sites.

Reference

[1] Daonian Liu, L.J.W, David W;"*Delivering a Chemistry Course over the Internet*", Journal of Chemical Education ;Vol.75 No.1 January 1998.
[2] Chris M, Mohammed J N, Penny J G; "*Web-based technology in a constructivist community of learners*", British Journal of Educational Technology, Vol 30 No 1 1999 pp.65-68.
[3] K. A Burke, Thomas J. G, Mark A. W; "*Developing and Using Conceptual Computer Animations for Chemistry Instruction*" ,Journal of Chemical Education., Vol. 75 No. 12 December 1998.
[4] Ned H. M; "*Integration of Computational Chemistry into the Chemistry Curriculum",Journal of Chemical Education*", Vol. 75 No.2 February 1998.
[5] Richard D. M; "*Chemistry on the Web*", Journal of Chemical Education; Vol 73 No.1 January 1996.
[6] Willian J. T, Jr; "*The Multimedia Chemistry Laboratory: Perception and Performance*", Journal of Chemical Education; Vol 73 No.9 September 1996.

The Development of a Multimedia Program for Teachers to Integrate Computers into the English Curriculum

Ya-Fung Chang
Center for Teacher Education, Tamkang University
151 Ying-Chuan Road, Tamsui, Taiwan 251
Tel: +886-2-26215656-2149
Fax:+886-2-26229751
Email: yfchang@mail.tku.edu.tw

A self-learning multimedia program was developed for English teachers' professional development in the integration of computers into the English curriculum. This program consists of four parts: (1) study guide (2) application cases (3) computer resources, and (4) related documents. In addition, a tool box is provided to gain access to a word processing system for taking notes, or to connect to a network discussion system for ideas exchange. This program was found satisfactory based on a preliminary evaluation. However, it will be upgraded continueously in the future. At the same time, a detailed study will be followed to investigate the effectiveness of its use.

Keywords: **Multimedia, System development, ESL teaching, Teacher professional development**

1 Introduction

It is said that the use of computer technology can create authentic and rich learning environments where learners' communication skills in English may be enhanced greatly.[1][2] To have such benefits, it is important to integrate computers into the English curriculum. In so doing, many factors such as computer technology, subject matters, learners, and even the environments all need to be taken into consideration. Above all, the key factor to successful integration is the school teacher. Teachers eventually need to take the responsibility of determining when and how to use computers, and assessing the effectiveness of computer use with their students.[3] However, a survey report in 1999 by the National Center for Educational Statistics still indicated such problem since only less than 20% of current teachers in American reported feeling very well prepared for technology integration.[4] The teachers in Taiwan also have the same problems. Neither do they know what kind of computer resources available, nor do they know how to apply them to their classroom instruction. In view of this, a multimedia program was developed for middle school English teachers so as to increase their competence and confidence in the instructional use of computers, and consequently to help them integrate computers into their instruction.

In the age of information technology, teachers are required to learn about technology. On the other hand, technology can be used to promote teacher professional development. For example, Hawkes proposed the use of network-based communication for teachers to gain access to professionally relevant knowledge.[5] However, the network installation is more complicated compared to that of cd-rom. Furthermore, the quality of Internet transmission for large amount of data such as videos is still below our satisfaction. Therefore, this multimedia program for English teachers currently resides on a cd-rom instead of a web site. However, technical support is available via telephone calls or e-mails. In addition, teachers can share ideas with others by connecting to a network discussion system.

2 The Developing Process

The Systems approach to instructional design has been adopted to guide the production of this multimedia program and thus to ensure the quality of its end product. [6][7] On the whole, the process includes four phases, namely, analysis, design, development, and evaluation/revision.

2.1 Phase of Analysis

Based on the review of the literature, there is a need to enhance teachers' willingness, competence, and confidence in the use of computers in their English classrooms. Due to the advantages of convenience and flexibility, a self-learning multimedia program is proposed. Basically this program attempts to achieve the following goals: (1) to stimulate teachers to rethink the new roles of teachers in an information society, (2) to help teachers understand the principles and strategies of the classroom use of comoputers, and thus generate some possible ways of applications, and (3) to encourage teachers to follow the application cases and lesson plans provided by this program and actually apply computers to their classroom instruction

2.2 Phase of Design

After several discussions with English teachers, English teaching experts, and instructional designers, a framework of this program is finally settled as shown in figure 1. The "study guide" gives an overview of the program' s goals, operation procedures, and contents to help users get an overall view of this program in a short time. Thus the users are able to decide the best way to use the program to meet their own needs. The "application cases" provides several cases about teachers' classroom use of computers in English teaching. Since these cases are realistic, it is believed that they would give teachers strong inspirations and implications. Each case contains useful information including: (1) background of the school and the teacher, (2) lesson plan of using comp uters in his or her classroom, (3) "teaching on the spot" in the video format, (4) student reactions based on the questionnaire and interview data, (5) teacher reflections about this practice, and (6) related issues pointed out by the designer.

The "computer resources" lists the titles of cd-roms and web sites useful for English teaching. The publisher of each cd-rom and a short description of its content are provided. The address of each web site, a short description of its content, and the computer screen of its homepage are displayed. The "related documents" includes a set of helpful information regarding implementing computer technology. For example, the "future education" outlines schools, teachers, and English teaching in the future. The "use of computers" describes the strengths of computers, identifies types of applications, and presents samples of lesson plans. The "user guide" points out the issues of intelligence properties and computer ethics. It also includes software evaluation sheets. "The Imp lementation guide" reminds teachers of some factors that need to be taken into consideration in implementing computers in their classrooms. Finally, the "references" lists the titles of related articles and books so that teachers can get more detailed information if needed. In addition, a tool box is provided to gain access to the word processing system for teachers to take notes whenever they need, and to connect to a network discussion system for ideas exchange and sharing.

2.3 Phase of Development

The programming tool for this multimedia program is Authorware 5.0, and the program resides on a cd-rom to enable easy distribution. To collect the data for the "application cases", the whole teaching process of each case is video taped. Afterwards, the teaching process is divided into several steps. Accordingly, suitable video screens are selected for each step. These video screens are then transformed and stored in mpeg files. At the end of instruction, the student is asked to fill in an attitude questionnaire. Furthermore, the teacher and several students are interviewed. The whole questionnaires are then analyzed statistically, while the interview data are examined in depth.

2.4 Phase of Evaluation/Revision

English teachers, English teaching experts, and instructional designers are invited to participate in a preliminary evaluation of this program. The focus of this evaluation includes content, screen design, media effects, interface design, and system operations. This program will thus be revised and expanded according to their opinions and suggestions. In the future, a detailed study will be followed to investigate the effectiveness of its use.

3 Results and Discussion

Based on a preliminary evaluation reports by two English teachers and one instructional designer, it was found that the program's content is plentiful and practical on the whole. Moreover, the screen design is of high quality, the interface design is user friendly, and the program's operation is easy and consistent. However, some of the video screens in the "application cases" look gloomy. Sometimes, it takes efforts to identify the key plot of these screens. Finally, it is suggested to increase the quantity and variety of the cases in this program.

In regard to the quality problem of the video screens, it is because the teacher turned off all the lights in the classroom to make more readable the computer displays by a portable projector. Consequently the quality of video recording was affected. As to the small number of the cases, it is because few English teachers ever used computers in their classrooms. Most of them dare not try it. The availability of the computer hardware is another problem. At that time, there was no computer lab available for English teachers. Therefore, the three cases currently included in this program all occurred in the regular classrooms where cd-roms, a notebook computer, and a portable projector were used.

To increase the quantity and variety of the cases in this program, two cases are collected afterwards. The two cases all occurred in the computer labs. In addition, e-mails and Internet resources were used. The program will be upgraded contitnueously in the future. At the same time, a detailed study will be followed to investigate the effectiveness of its use. Questionnaires on computer literacy, and attitudes toward this self-learning program, as well as the design of lesson plans will be used to collect the outcome data. The net discussion tracking system, and the journal writing will be used to collect the process data. In addition, relevant suggestions will be provided regarding optimal strategies and necessary supports which go well with the use of this self-learning multimedia program.

4 Conclusions

A self-learning multimedia program was developed for English teachers' professional development in the integration of computers into the English curriculum Based on a preliminary evaluation, the program was found satisfactory. However, it will be upgraded continueously in the future. At the same time, a detailed study will be followed to investigate the effectiveness of its use.

References

[1] Kumar, V. S. ,Anjaneyulu, K.S.R,• Gupte, U. A., "VIDYA:A situated CALL environment", Computer Assisted Language Learning, Vol. 10, No. 2, pp149-172, (1997).

[2] Zhao, Y., "Language learning on the World Wide Web: Toward a framework of network based CALL", CALICO Journal, Vol. 14, No. 1, pp37-57, (1996).

[3] Keith, W.• ines, C., "An evaluation of technology integration in teacher education for bilingual and English as a second language education majors", Journal of Research on Computing in Education, Vol. 30, No. 4, pp379-395, (1998).

[4] Schrum, L., "Technology professional development for teachers. Educational Technology", Research and Development, Vol. 47, No. 4, pp83-90, (1999).

[5] Hawkes, M., "Exploring network-based communication in teacher professional development", Educational Technology, Vol. 39, No. 4, pp45-52, (1999).

[6] Dick, W., & Carey, L., "The systematic design of instruction", Glenview, IL:Scott Foresman Company, (1985).

[7] Seels, B. & Glasow, Z., "Exercises in instructional design", Columbus: Merrill, (1990).

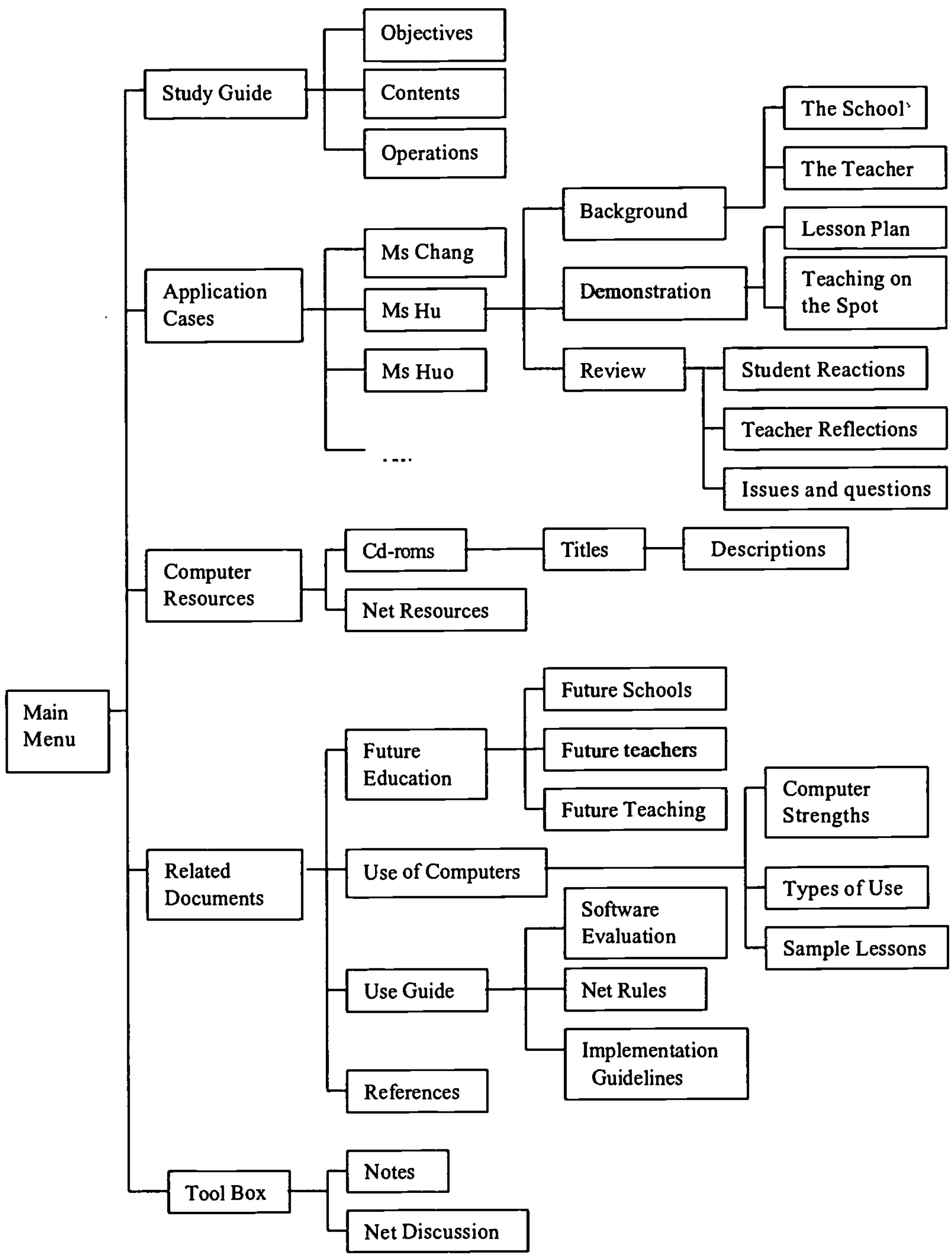


Figure 1 Framework of the multimedia program
Figure 1 Framework of the multimedia program

The Impact of Learning Style on Group Cooperative Learning

Fang-yi Hu* and Nian-shing Chen*
** Dep. of Information Management, National Sun Yat-sen University*
70, Lian-hi Road, Kaohsiung, Taiwan 804
Tel: +886-7-5252510
E-mail: fyhu@power2.nsysu.edu.tw; nschen@cc.nsysu.edu.tw

Cooperative learning has been around a long time and there are many researches and practical uses of cooperative learning. This study is to examine students' attitude toward group cooperative learning processing with individual's underlying learning style. We use Gregorc's Learning Style Delineator to group students heterogeneously and use some factors of Social Cognitive Theory to measure group processing. The findings indicate students with concrete/sequential learning style are tentative to be lack of self-efficacy on setting their goals and therefore teachers should take more care of them while doing group cooperative learning activities.

Keywords: **Cooperative Learning, Learning Style, Social Cognitive Theory**

1 Introduction

Cooperative learning means students working together to accomplish shared learning goals and to maximize their own and their group members' achievements (Johnson & Johnson, 1994). Cooperative learning is widely adopted by the educators since 1980s. Students perceive that they can reach their learning goals if and only if the other students in the learning group also reach their goals (Deutsch, 1962; Johnson & Johnson, 1989). A vast amount of evidence from research in related areas suggest that in cooperative learning situations there is a positive interdependence among students' goal attainments.

Although cooperative learning makes students to learn much better than competitive learning and individual learning in groups, there are still many potential barriers to make group effective, such as lack of sufficient heterogeneity, lack of groupthink, free riding, and lack of teamwork skills (Johnson & Johnson, 1994; Johnson & Johnson, 1996). The basic elements of making cooperative group with high performances are positive interdependence, face-to-face promotive interaction, individual and group accountability, appropriate use of social skills, and group processing (Johnson & Johnson, 1996). Thus how students interacting with other group members and groups processing are the critical successful factors in cooperative learning. By considering individuals' underlying learning style, the purpose of the study is to examine students' attitude toward group cooperative learning processing.

In the Bostrom, et al. (1988) framework individual difference variables define the cognitive aspects of human activities. Thinking process is at the heart of all such activities including learning. Learning style is one of the cognitive traits, which are static aspects of information processing affecting a broad range of variables (Bostrom, et al., 1990). To aim for sufficient heterogeneous grouping, this study chooses learning style as the main variable concerning the impacts of group cooperative learning.

To examine individual's interaction during group processing, this study use Social Cognitive Theory (SCT) (Bandura, 1986), a widely accepted and empirically validated model of individual behavior (Compeau & Higgins, 1995), to reflect the cognitive aspects of students' learning activities, such as self-efficacy. SCT emphasizes the triadic reciprocal causation of behavior, cognitive and some personal factors and environmental events (see Figure 1). Three aspects of Social Cognitive Theory are especially relevant to the organizational field (Bandura, 1988; Wood & Bandura, 1989): the development of people's cognitive, social, and behavioral competencies through mastery modeling, the cultivation of people's beliefs in their capabilities so that they will use their talents effectively, and the enhancement of people's motivation

through goal systems.

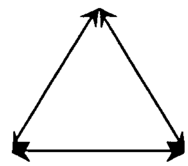


Figure 1. Schematization of the relations among behavior (B), cognitive and other personal factors (P), and the external environment (E) (Bandura, 1986; Wood & Bandura, 1989)

According to Social Cognitive Theory, many researches showed that past performance, self-efficacy and goal setting are the main personal factors effecting performance. Although there are many other factors in the range of the theory, we just discuss the impact of learning style on self-efficacy and goal setting in this study.

There are some other factors exerting considerable influence over group performance. For example, group cohesiveness and group norms. Cohesiveness means all forces (both positive and negative) that cause individuals to maintain their membership in specific groups. Group cohesion means the mutual attraction among group members and the resulting desire to remain in the group. Norms means the rules or expectations that specify appropriate behavior in the group and the standards by which group members regulate their actions (Johnson & Johnson, 1996). Group performance is affected by the combination of cohesiveness and group norms rather than cohesiveness alone (Langfred, 1998). In this study, we also investigate the impact of learning style in group cohesiveness and norms.

2 Method

2.1 Subjects

The subjects were 43 girl's senior high school students who participated in the AJET (Advanced Joint English Teaching, *http://ajet.nsysu.edu.tw*) project, which was supported by MOECC (Ministry of Education Computer Center, APNG-Education (Asia Pacific Networking Group) and I*EARN in Taiwan (*http://www.iearn.edu.tw*). Therefore there are no differences in sex and age among them. The subjects were run in groups and Table 1 is their proportion of learning style. We' ll explain the types of learning styles later.

Table 1. Learning Style Frequencies

Learning Style	AR	CR	AS	CS	Total
Students Numbers	15	17	7	4	43

Every group was assigned a project to make English web pages about one topic: Signs or Foods in 6 weeks. Every week they had tow hours on learning how to make homepages by Microsoft FrontPage 98 and doing their group' s project as exercises in the computer classroom. Before the experiment, they had learned some basic skills for building their own personal webs.

2.2 Procedure

During the 6 weeks, there were three 2-week sections in the experiment. In the first week, the subjects were asked to fill out the self-efficacy, goal setting and group cohesiveness questionnaires. The same questionnaires were conducted in every section. And in the second week, they were asked to fill out the group norm and satisfaction questionnaires after their performance measurement made by the teachers.

2.3 Measure

According to the procedure, this study assessed learning style and 5 constructs: group norms, group cohesiveness, self-efficacy, goal setting and satisfaction.

2.3.1 Learning Style

In this study, the Gregorc Learning Style Delineator was used to measure the learning style (Gregorc, 1982). Gregorc' s model is one of several models developed to improve understanding of the way students learn and the way teachers teach and is a cognitive model designed to reveal two types of abilities, perception and ordering. Perceptual abilities mean through which information is grasped, translate into two qualities; abstractness and concreteness. Ordering abilities are the ways the learner organize information, either sequentially (linearly) or randomly (non-linearly) (Leuthold, 1999). Thus there are four learning categories: abstract/ random (AR), concrete/random (CR), abstract/sequential (AS) and concrete/ sequential (CS).

2.3.2 Group Norms

Group norms was measured by 5 items on 7-point scales, which indicate the amount of effort put into work, the attitudes toward work load, the willingness to give up free time to work, the feeling of responsibility for work goal attainment, and the feelings of self-worth when work is accomplished well. This measure is developed based on the literature of group work norms (Langfred, 1998). The Cronbach alpha for the group norms measure was .839.

2.3.3 Group Cohesiveness

Group cohesiveness was measured by 6 items on 7-point scales, which defines the feeling of individual group members toward other members and the group. This measure is based on the literature of Langfred (1998). The Cronbach alpha for the group cohesiveness measure is .79.

2.3.4 Self-efficacy

Self-efficacy was measured by 8 items, which asked the respondents to rate their expected ability to accomplish the project with different levels of goal. For example, the respondents were asked whether they could accomplish fifty percent of the project and how much confidence they have. This measure is developed based on an extensive review of the literature of self-efficacy (Compeau & Higgins, 1995). The Cronbach alpha for the self-efficacy measure is .963.

2.3.5 Goal setting

Goal setting was measured by 4 items, which asked the subjects' commitment to their goal of the projects. This measure is developed based on the literature of goals (Locke, 1984). The Cronbach alpha for the goal setting measure was .68.

2.3.6 Satisfaction

Satisfaction was measured by 5 items on 7-point scales, which asked the subjects' satisfaction of the performance of their group project. This measure is developed based on the literature of satisfaction (Dennis, Kinney & Hung, 1999). The Cronbach alpha for the satisfaction measure was .913.

3 Results

Since the Cronbach alpha values of all experiment measures are .891, .8767 and .8646 respectively, this experiment was reliable. An overview of the data is displayed in Table 2, and the results are displayed in Figure 2, 3, 4, 5 and 6.

Table 2. The mean of every measure

Mean	Group Norms	Group Cohesiveness	Self-efficacy	Goal setting	Satisfaction
Section 1	5.16	4.90	529.77	5,66	4,94
Section 2	4.90	4.60	561.16		4,56
Section 3	4.86	3.76	574.42	5,60	5,05

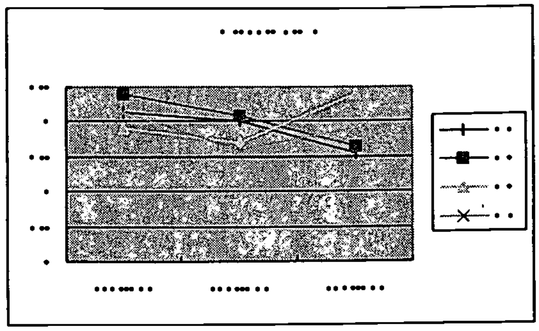


Figure 2. Effects of Learning style on group norms

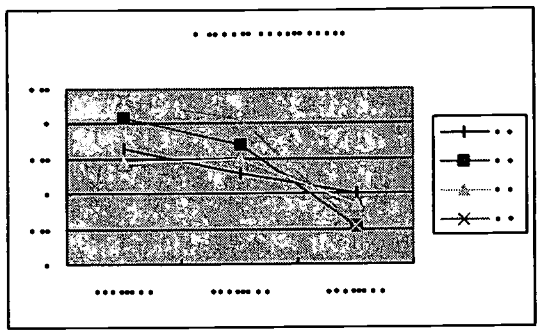


Figure 3. Effects of Learning style on group cohesiveness

The effects of learning style on group norms and group cohesiveness in the three 2-week experiments are not statistically significant, and the results are showed in Figure 2. Because the subjects were grouped since three months ago in the beginning of the semester, the group norms were already statically existed and were identified with group members.

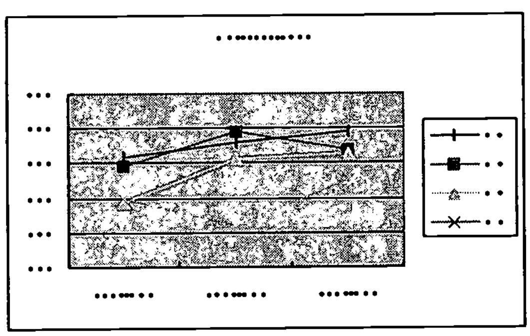


Figure 4. Effects of Learning style on self-efficacy

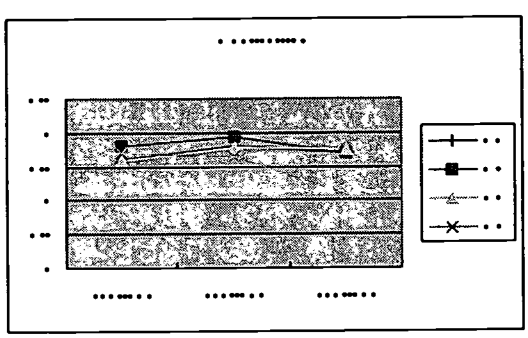


Figure 5. Effects of Learning style on goal setting

The effects of learning style on self-efficacy and goal setting are more significant than group norms and group cohesiveness. The results are showed in Figure 3. Students with concrete/sequential learning style had less self-efficacy during the experiment and were afraid to set their goal higher. Maybe the CS style students feel difficult to make web pages since it is somehow an abstract skill and needs to think randomly.

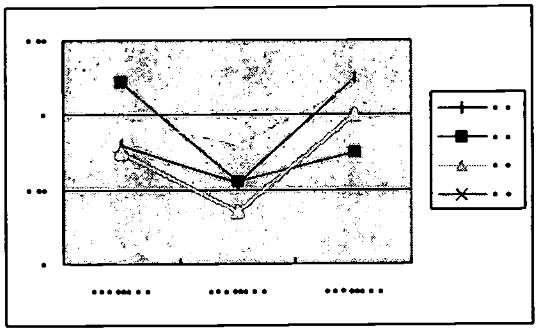


Figure 6. Effects of Learning style on satisfaction

The effects of learning style on satisfaction don' t have significant differences, and the result is showed in Figure 4. It showed that all students enjoyed group cooperative learning and were satisfied in this way of learning.

4 Conclusions

In general, all students performed well in the group cooperative learning and felt satisfied with group processing. Although the students with concrete/sequential learning style were few and far between the subjects in this experiment, a quarter of general students would be this kind of learning style. Teachers should give them more encouragement to make them getting more self-efficacy and setting the right goal. Moreover, this study only uses Gregorc Learning Style Delineator to examine students' learning style. There are many other kinds of learning style evaluations, such Kolb' s (1976) Learning Style Inventory (KLSI), Canfield' s (1988) Learning Styles Inventory, etc. Future researches may use these questionnaires to examine which one is more suitable for cooperative learning.

And about the Social Cognitive Theory, there were many studies showed that the triadic aspects could form some models, which would affect each other in some relationships. Since the sample size is too small, this study doesn' t prove the model by statistic methods. This is a limitation of this study. Understanding the effects between group norms, cohesiveness, self-efficacy and their performance will be an interesting research topic.

References

[1] Bandura, A., "Social Foundations of Thought and Actions: A Social Cognitive Theory", Englewood, Cliffs NJ: Prentice-Hall, (1986).

[2] Bostrom, R. P., Olfman, L. & Sein, M. K., "End User Computing: A Framework to Investigate the Training/Learning Process", Human Factors in Management Information Systems, H. M. Carey (ed.), Ablex Publishing Corporation, Norwood, NJ, pp. 221-250, (1988).

[3] Bostrom, R. P., Olfman, L. & Sein, M. K., "The Importance of Learning Style on End-User Training", MIS Quarterly, pp. 101-119, (1990).

[4] Compeau, D. R. & Higgins, C. A., "Application of Social Cognitive Theory to Training for Computer Skills", Information Systems Research, Vol. 6, No. 2, pp. 118-143, (1995).

[5] Dennis, A. R., Kinney, S. T., Hung, C., "Gender Differences in the Effects of Media Richness", Small Group Research, Vol. 30, No. 4, pp. 405-437, (1999).

[6] Deutsch, M., "Cooperation and Trust: Some Theoretical Notes", In M. R. Jones (ed.), Nebraska Symposium on Motivation, Lincoln: University of Nebraska Press, pp. 275-319, (1962).

[7] Johnson, D. W. & Johnson, R. T., "Cooperation and Competition: Theory and Research", Edina, MN: Interaction Book Company, (1989).

[8] Johnson, D. W. & Johnson, R. T., "Learning Together and Alone: Cooperative, Competitive and Individualistic Learning", 4th ed. Allyn and Bacon, (1994).
[9] Johnson, D. W. & Johnson, R. T., "Joining Together: Group Theory and Group Skills", 6th ed. Allyn and Bacon, (1996).
[10] Kolb, D. A., "The Learning Style Inventory Technical Manual", McBer and Company, Boston, MA, (1976).
[11] Leuthold, J. H., "Is Computer-based Learning Right for Everyone", Proceedings of the 32nd HICSS, pp. 1-8, (1999).
[12] Loke, E. A., Frederick, E., Lee, C. & Bobko, P., "Effect of Self-efficacy, Goals and Task Strategies on Task Performance", Journal of Applied Psychology, Vol. 69, No. 2, pp. 241-251, (1984).

The Production of Web-based Interactive Video From Structured Script

Cheng-Huang Yen
Dept. of Management & Information, National Open Univ.
172 Chung-Cheng Road, Lu Chow, Taipei County, Taiwan 24702
Tel: +886-2-22894846
Fax: +886-2-28484944
E-mail:yench@mail.nou.edu.tw

The use of AV (audiovisual) media has had great impact on instruction in distance education. However, lack of a systematic methodology, existing instructional video programs cannot be used as effectively on Web as in the case of TV broadcast. Simply by digitizing video programs to AV streams will not gain much from learners' view. In our research, we propose the notion of structured script writing. The design and production of Web-based interactive video from structured script enhances reusability of content modules and reduces demand on network bandwidth. Most importantly, learners are able to conduct a hyperlink-style learning process which turns out to be much more effective than viewing video programs sequentially. Learning activities are also easily integrated with digitized media.

Keywords: **Web-based learning, Distance education, Audiovisual media production**

1 Introduction

TV production has been an effective, though expensive way to create AV media for instructional purposes. Every finished video includes an amalgamation of elements recorded in a script. A script simplifies production by specifying what and how settings, action, and actors become part of the video so the director can plan ahead. Although TV production runs routinely, the quality and effectiveness of every instructional video differs significantly. It has been evidenced that the script stage is critical for successful TV production. In our research, we take script writing to another level; i.e., structured script. The major goals are as follows:

1. *Enhance reusability of content module:* The video programs can be partitioned into reusable modules such that instructional elements may be reused or shared among different programs. Structured scripts lead to a natural partition of video programs.
2. *Facilitate the design of Web-based learning material:* The notion of hyperlinks has been used in the production of Web-based learning and training material. Embedded standard and extended tags appeared in structured scripts can map video content to HTML-like format. The mapping can be automated by software.
3. *Reduce the demand on network bandwidth:* Without partition, video programs are streaming down to users' computers which are normally hooked up to the Internet by low bandwidth access lines. A proper partition by topic will eliminate the need to transfer the whole program and thus save 30% to 70% of bandwidth usage.
4. *Automate the production of Web-based interactive video:* A typical distance education institution produces an average of 40 video programs per semester. The length of a video program ranges from 30 minutes to 20 hours. This amounts to a mass production of instructional video programs within a very short timeframe. It is both a need and a demand to automate the transformation of traditional video program to Web-based interactive video. The channels of distribution can also be diversified.
5. *Enable flexible learning sequences:* Traditional TV broadcast forces learners' to follow a non-stop sequential format which is inconvenient and against the nature of individualized open learning. Web-based open learning provides a variety of learning sequences and formats.

2 Related Research

In our research, video-based instructional media refer to traditional studio production or live instructional activities recorded on tape for later broadcast or distribution [8]. From learners' point of view, simply by watching the instructional video offers no experience of interaction. However, the visual content along with good design at the script stage could provide great assistance to learners, especially in the area of distance education. The use of interactive video in instruction and learning has been practiced extensively in both academic and corporate environments [3,5]. Improvised video programs can hardly provide effective assistance in a formal learning situation which requires precision and in-depth coverage.

Including the script stage in the video production process is a legitimate choice in most successful cases [4,8]. However, the sequential and flat nature of traditional script does not leave much room for integration with other media and for adding interaction. Structured scripts, like HTML in WWW, open a new way for producing effective Web-based interactive video. Recent advances in virtual university and network-based education suggest widespread use of computer-based media [1,2]. AV media can become part of the computer-based media [7]. However, traditional institutions need to pay for extra investment on video production and distance education institutions need to find a way to transform their video assets to digital merchandise. Structured scripts will help solve the dilemma.

3 A Definition of Structured Script

A typical script includes a video and an audio part presented along a sequential timeline. Various techniques can be used to enhance the presentation of instructional content in a video program. The elements of a script may appear in any format listed in Table 1. The adoption of these formats depends on the nature of the program, the design by content and media expert, etc. A script may contain a combination of several different formats of presentation.

Table 1. Popular presentation styles

1	*Commentary*
2	*Single performer*
3	*Interviews*
4	*Talk shows*
5	*Illustrated talk*
6	*Demonstrations (music/dance/computer)*
7	*Drama*
8	*Electronic insertion*

Most script writers are aware of different formats of presentation. However, few of them notice the formats' implications on how the video programs can be partitioned. Table 2 lists a typical script that follows traditional style. Based on the script, the director knows when, what and how to record on the tape. The actor is also aware of what should be performed by viewing the script. By the time the video program is finished, we need to scan through the tape to find a way to divide the program into video content modules. Just by looking at the script will not give us much clue about how the partition should be made.

Table 2. Non-structured scipt

Video	Audio
TC Java Basics 1. basic concepts 2. resources 3. related topics	Java is an object-oriented programming language. JDK (Java Developer's Kit) provides Java compiler and other tools for developing Java applications. ......
SP	Java is noted for its support for cross-platform software development. Many Internet applications are written in Java.

Without making too much change, we re-write the same script as shown in Table 3, the so-called structured script. In our definition, a traditional script is composed of a video and an audio part synchronized along the timeline. A structured script is, on the other hand, distinguished by the following features:

1. *The margin of divisible units should be clear.* Suppose the video program will be partitioned by topics, the start and end of a topic should be signaled by some sort of tags. For example, the STC tag in Table 3 denotes the start of the topic, Java.
2. *There exists a hierarchy that organizes and inter-relates all units.* For example, the script in Table 3 reveals a hierarchy shown in Figure 1. The elements in the video part must be organized by certain content-specific criteria.

Table 3. Structured script

Video	Audio
STC Java	(music)
TC Java basics	Java is an object-oriented programming language. JDK
1. basic concepts	(Java Developer's Kit) provides Java compiler and other
2. resources	tools for developing Java applications. ……
3. related topics	
SP cross-platform	(Java is noted for its support for cross-platform software
software development	development. Many Internet applications are written in
	Java.)
Demonstration :	……
My first Java program	Step1. Enter MS-DOS mode,
	Step2. Type in a Java program,
	Step3. Compile and test the program.

Table 1 suggests a taxonomy of video contents by the formats of presentation. There are other ways to classify the same information in a script; e.g., the table of contents of a course or a lesson. No matter which classification scheme is chosen, the content of a script will be structured according to some sort of criteria. The resulting structure leads to reusable content modules. In the design of Web-based content, these modules can easily be organized in hyperlink-style Web pages. In our research, structured script writing follows well-defined style guide which can be specified by the tags' syntax and semantics. In a practical situation, a structured script editor can be used to help follow the rules.

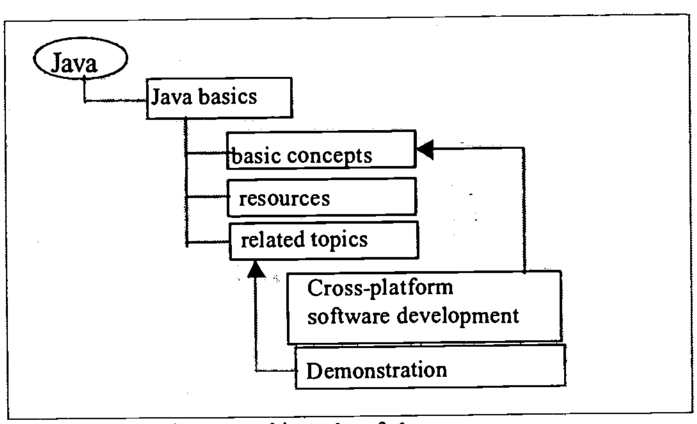


Figure 1. A hierarchy of elements

4 The Process and Methodology

Although TV broadcast still plays a major role in reaching most audience, network-based media have been growing in a pace much faster than traditional media. Since all kinds of media can be digitized and integrated into computer files, there is possibility that video-based instructional media can also be distributed in the form of network-based media. However, the design and production of traditional video-based instructional media has not been guided along this direction. Most existing instructional tapes are not able to function at least as well on the network, not to mention adding learning activities or interaction to these video programs.

Our research is focused on establishing a methodology and a mechanism for producing instructional video that works for broadcast and is able to help learners on the network. We are not aimed to investigate technical details on post-production of digital media. Instead, we are trying to look for answers on the following question, ``what kind of content in what format should be included in instructional videos and how?'' Figure 2 shows an overview of the production process. TV broadcast is more expensive and less flexible than distribution through Web hosts. However, Web access consumes a significant amount of network bandwidth for AV streams. On the other hand, studio production of videos is expensive. In the same professional area, many topics are likely to overlap in different programs. To reduce cost and enhance effectiveness, we can take advantage of studio production of video programs by changing the process of the script stage in a way that finished videos can easily be transformed to Web-ready media. The script stage is critical since later production steps are all based on the finished script.

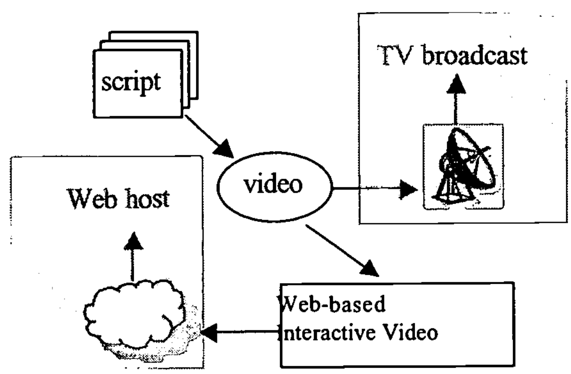


Figure 2. An overview of the production process

In order to achieve optimality among cost and effectiveness factors, there is a need to divide video programs to well-defined units. By well-defined we mean the unit should be complete and self-explanatory. Once the video program is divided into units, Web-based media will be feasible since viewers will not need to download the entire video program. The problem of reproducing the same content can also be avoided since the video unit is reusable. Obviously, the script stage is the most critical step toward a favorable solution. We re-shape the script writing process in the following ways:

1. *Component-based script creation*: Script writers or designers must be able to identify the components appeared in the script. Instead of dividing a script into components, we suggest a practice of component-based design at the beginning. Every component is identified by certain criteria; e.g., topic, presentation format, etc.
2. *Hierarchical planning*: The content of a script comes from a course or a lesson. The structure of the course or lesson is embedded in the script. At the script stage, how the content is divided or inter-related should be planned ahead. Later production of Web-based material will benefit from the pre-built hierarchy. Since the hierarchy is strongly content-specific, content expert should play the key role in this process.
3. *Extended tag set:* Existing notations used in script writing do not provide enough modeling capability for automated partition of structured scripts. We use an extended tag set. Part of the set is listed in Table 4. With this addition, it becomes feasible to develop a software editor for the creation and processing of structured script. The syntax and semantics of these tags are part of the style guide for structured script writing.

Table 4. Extended tag set for script writing

Tag	Usage
STC	The starting point of a topic
TC	Tele-card
SP	Superscription
VC	Video clip
CV	Computer video
CM	Commentary

Once the script is created structurally, studio production can proceed as usual. The next step is to import digital Beta-cam video source onto a post-production workstation. The video source becomes computer files. Since the original structured script contains meaningful tags, we can divide the video file into content modules based on the semantics of these tags. Figure 3 shows that the content modules can then be incorporated in the design of Web pages. These pages may be used and reused in various lessons, courses, and curriculum. There exists a transition between toc (table-of-contents) style and hyperlink style domain-specific contents.

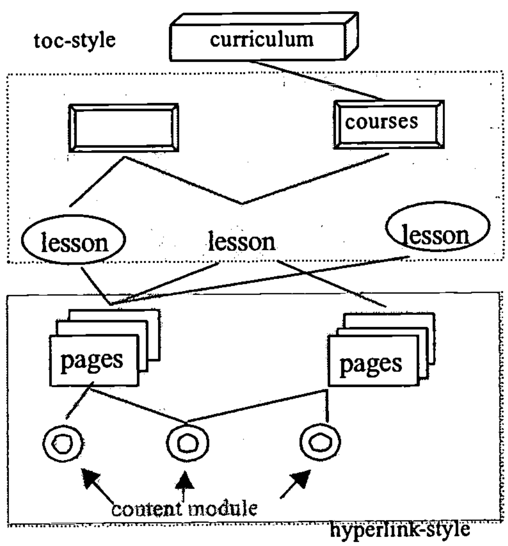


Figure 3. From toc-style to hyperlink style content presentation

The video content modules have no interaction at all. To add interaction to Web-based material, a variety of learning activities can be designed and integrated with various instructional media [6]. Figure 4 depicts the flow of learning activities. Learners start to work on the assignment through the interface of the Web browser. The assignment has been designed to help learners follow a sequence of steps to get result for discussion. The learning process can be evaluated and repeated. After finishing the assignment, learners may perform a test to see their own progress and head to the next assignment. In Figure 4, we can see that the video components produced from structured scripts are used for creating Web-based learning material. With the addition of the interactive design, the original video components are transformed to interactive video.

BEST COPY AVAILABLE

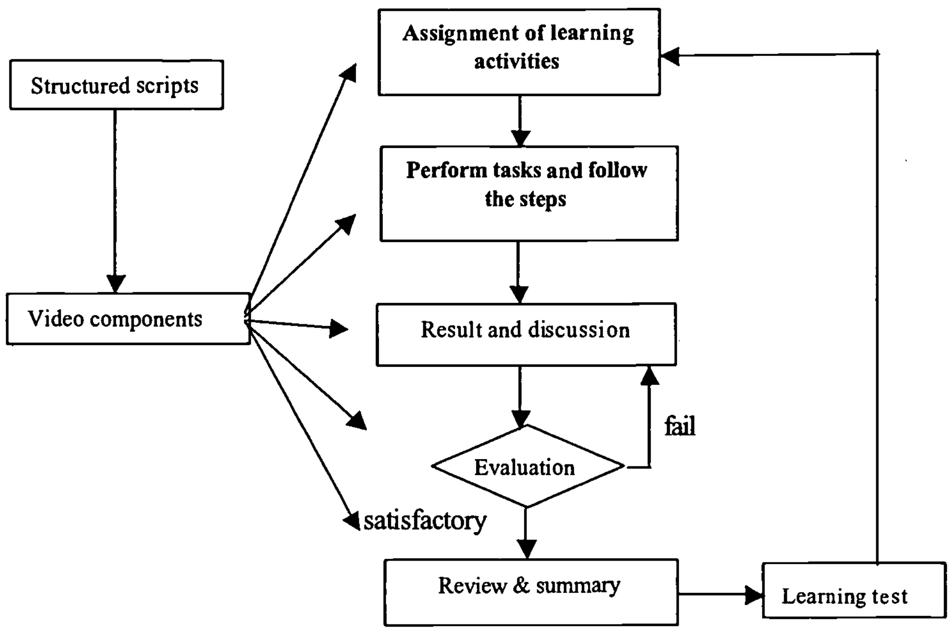


Figure 4. Interactive learning component

5 Experience Report

We choose a computing course, Data Structures, to exemplify the reference model resulted from the research. The reference model describes a formal process for producing instructional video suitable for integration with other digitized instructional media. Feedback and analysis collected from activities and experience of teaching the course is used to explain the strength and weakness of our approach.

1. Learning with interaction provides essential experience for successful learning.
2. Video programs alone are not able to provide required interaction.
3. Structured scripts are helpful for designers of Web-based instructional material.
4. The extended tag set for structured scripts should be clear and easy to use.
5. The reference model needs more instances to exemplify the use of tags, style guide, partition criteria, etc.

6 Conclusions

The learning experience by viewing a video program is different from browsing through a CBT (Computer-Based Training) lesson. However, the video part of both; i.e., traditional video programs and CBTs, may come from the same studio production process. Structured scripts have the potential of making video programs suitable for both TV broadcast and Web hosting. Content experts will take more responsibility on improving the quality and effectiveness of instructional videos. Media experts should carry on to provide assistance on the integration of learning activities with video content modules. Technical staff will then have enough information to build Web-based interactive video and other related learning and instructional material.

References

Burgess, W. E. *The ORYX Guide to Distance Learning*. 2nd Ed. ORYX PRESS, 1997.
Chellappa, R., Barua, A., and Whinston A. B. ``An Electronic Infrastructure for a Virtual University". *Communications of the ACM*, pp. 56-58, 1997.

····Collis, Betty. *Tele-learning in a Digital World : The Future of Distance Learning*. Thomson Computer Press, 1996.
····Eustace, G. *Writing for Corporate Video*. Focal Press, 1990.
····Hall, Brandon. *Web-Based Training Cookbook*. John Wiley & Sons, 1997
····Horton, W. *Designing Web-Based Training*. John Wiley & Sons, 2000.
····McCormack, C., et al. *Building a Web-Based Education System*. Wiley Computer Publishing, 1997.
····Millerson, G. *Effective TV Production*. Focal Press, 1983.
····Swain, D. V. *Scripting for Video and Audiovisual Media*. Focal Press. 1981.

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 education1 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 $\alpha = 0.05$, 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 $\alpha = 0.05$, 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.

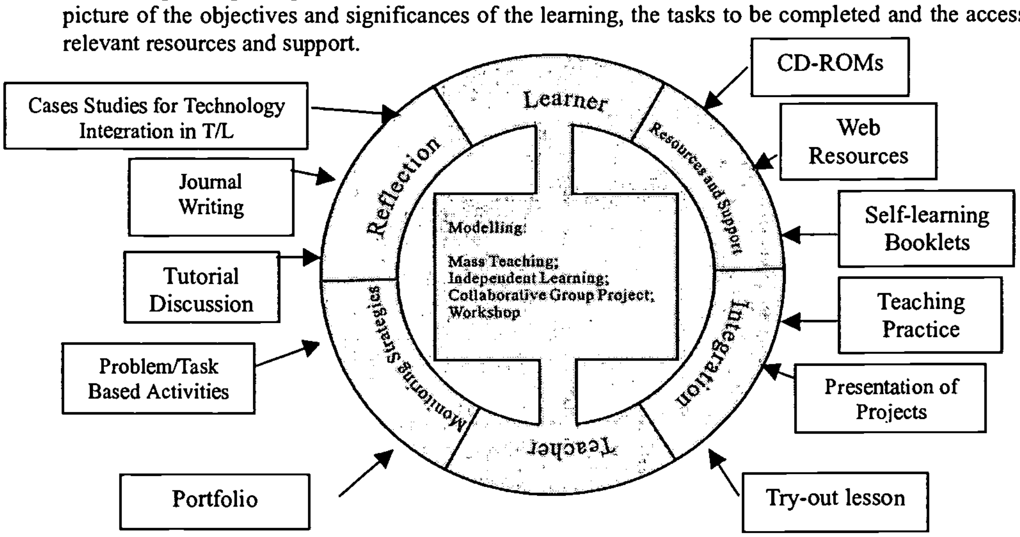


Figure 1: A teaching model of using IT in education for teacher education

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.

NOTICE

REPRODUCTION BASIS

- [x] 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").