

Using Constructivism and Scaffolding Theories to Explore Learning Style and Effect in Blog System Environment

Jamie Y.T. Chang¹, Eric T.G. Wang², Ruey-Ming Chao³

¹*Department of Information Management, National Central University*

²*Department of Information Management, National Central University*

³*Department of Social Science and Information, National United University*

ABSTRACT: *This study is based on the theory of Constructivism and Scaffolding to implement a Blog system environment which allows users to create their own personalized Blog for individual, group, and organization practice. The Blog system is a platform for members to exchange their ideas and thoughts in order to achieve the goal of knowledge sharing and then enhance learning effects of the students. This study utilizes the quasi-experiment method and survey research to aim at the target sample of the e-learning related curriculum provided by the department of Information Systems. A fourteen-week experiment was conducted to explore for whether the interaction of teaching strategy and learning style based on the Constructivism and Scaffolding would enhance student learning effects. The results of two-way MANCOVA analysis reveals: (1) the learner's learning style has no significant influence on their learning effects, (2) teaching strategy based on the Constructivism and Scaffolding can improve learner's learning effects, and (3) under the interaction of teaching strategy and learning style, the experimental group shows better learning effects.*

KEYWORDS: *Blog, Learning Effects, Constructivism, Scaffolding.*

1. Introduction

Under knowledge economy and information technology immersion, education has richer information sources and channels. Information technology freed traditional one-way communication in learning environment and provided multiple learning methods. As information technology and computer network changed the way people live and learn, all classes of life in the society are affected by *electronic revolution*. One of the key research background factors in this study is to master update of knowledge development and

achieve learning goals with assistance of information technology. Electronic learning is getting increasingly important. There are some disadvantages of electronic learning now to be improved such as expensive copyright technology, complicated operation, one-way interchange, difficulty to receive real time messages and emphasis of individual values, etc.

In traditional learning environment, teachers are unable to provide appropriate assistance for individual learners. This causes one-way communication from teachers to students (Clasen and Bowman, 1974; Felder and Brent, 1996). In the unlimited application of information, through the Internet, learners can start learning anywhere. Teachers can supervise learning conditions of individual learners. Interaction and observation among learners is made easier. In electronic learning, students shall be taught in accordance with their aptitude to obtain appropriate assistance and support based on their learning abilities and tendencies.

WebCT and Blackboard, the two world famous electronic learning platforms, offer strong Internet education, although there are still some limitations (Du and Wagner, 2005). According to Reynolds (2004), the two platforms would lose one fourth market to be taken over by companies with free and open source. The currently popular writing tool over the Internet, Weblog (Blog), is also based on free and open source in simple operation, low priced input and open Internet environment to express individual composition and group wisdom, which made up the lacked flexibility and openness of the electronic learning (Mitchell, 2005; Wagner, 2003). Blog provides learners with self-constructivism and, with feedback and comment, to support scaffolding results (Ferdig and Trammell, 2004). Du and Wagner (2005) pointed out that Blog was a good constructive learning environment where learners can learn freely in an open space. Thus, focusing on education theory level, the research explores learning results in Blog system based on constructivism and scaffolding theories. This is the first purpose of the study.

In electronic learning, learners are the center of learning activities. Teachers teach in accordance with students' aptitude and arrange peer interaction based on learning preferences and scenarios. Relevant empirical studies are still unavailable and the results do not correspond to one another (Jones et al., 1996; Freitag and Sullivan, 1995; Okebukola, 1986). Teaching strategies and learning activities design affect the learning willingness and performance. Without comprehensive interaction planning, electronic learning system will not only help learning but also may cause negative results in teachers and learners. The paper, as a result, explains and uses the teaching strategies in electronic learning and examines whether learning styles influence learning results. Learning of different qualities and used teaching strategies on interaction effects of learning results is the second purpose of the paper. The research proposes three questions:

1. In Blog system environment, do teaching strategies enhance learning results with practice and dimension of scaffolding theories?
2. In Blog system environment, will students with different learning styles have different learning results in different teaching strategies?
3. In Blog system environment, what is the relation among system quality, teaching strategies, learning satisfaction and learning performance?

2. Literature exploration

2.1 Theory foundation of web-based learning

Constructivism and scaffolding theories are getting more and more important in exploration of learning process. The two focus on inner mental process of learners. Teachers shall emphasize the two theories in teaching.

2.1.1 Constructivism

It is proposed by Piaget in 1928 of knowledge, exploring how to obtain knowledge or get to know the nature of knowledge (Bodner, 1986). It is also a strategy of renovation of education and learning as well as teaching theory. The theory claims to transfer focus from instructors to learning itself in teaching and emphasizes: (1) knowledge is active construction by learners, not passive receipt or absorption; (2) knowledge is the rationalization or practice, not memorizing facts or truths, of learners' experience; (3) knowledge is the common consensus from interaction and negotiation among learners and other people (Osborne and Wittrock, 1983; Rogoff, 1990; Von Glasersfeld, 1984; Chang, 1997). Constructive learning emphasizes learning process. Constructivism covers two levels:

2.1.1.1 Individual constructivism

Human knowledge is from individual active construction, not passive receipt or absorption (Osborne and Wittrock, 1983). Constructive knowledge is not from outside to inside. Instead, it is construction or understanding from inside on outside people, matters and objects. Learners are the main roles in learning and, based on the available experience to interpret teaching materials from teachers, actively engage in various learning activities to review the original knowledge and then construct new knowledge.

2.1.1.2 Social constructivism

Social constructivism holds that knowledge is common consensus from interaction and negotiation among people. It emphasizes that individual knowledge is constructed

under social culture environment (Rogoff, 1990; Vygotsky, 1978). Social constructivism focuses on inter-subjectivity and allows mutual thinking, problem solving and decision making process. Learners obtain new knowledge from such process.

2.1.2 Scaffolding

It was proposed by Russian psychologist, Vygotsky, in 1978, emphasizing human high level mental activities existed in social interaction from the beginning other-regulation, or social negotiation, to internal self-regulation. Scaffolding integrates Piaget's constructive cognitive theory of individuals on knowledge and *Vygotsky's Zone of Proximal Development (ZPD)* of teachers and students' dialogues in social discrimination and authentication of negotiation. When students remain at a certain level of cognition, if teachers or peers systematically guide them or give the key instruction, students tend to go beyond the original cognitive level more easily. Various teaching methods guide students to develop into a higher level to have learning transfer (Meyer, 1992). In this study, with record, feedback and quotation in Blog system, students express what they learn on the platform to have self-study through thinking aloud. They correct their own concepts from feedback and comments of others. Under teachers' strategies and Blog characteristics, learners' learning transfer was guided.

2.2 Learning performance

Bostrom et al. (1990) proposed a comprehensive theory framework based on information system education training. The framework integrates cognitive psychology, education psychology, information system and computer science. Bostrom et al. (1990) believed that interaction of the three major factors, target system, individual differences of users, and training methods, affected training output of information system in direct influence and indirect influence via users' mental model as in Figure 1.

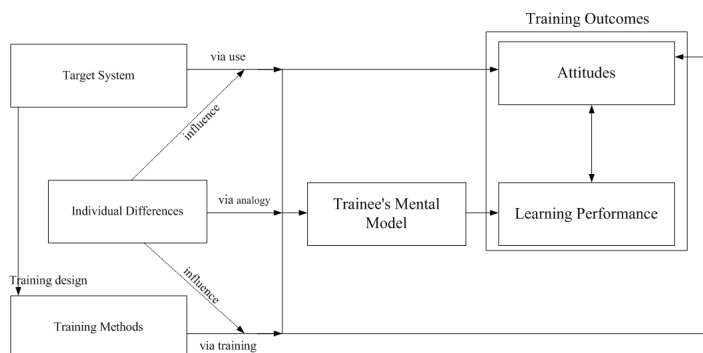


Figure 1 Training Model (Bostrom et al. 1990)

The study construction of Bostrom et al. (1990) is wide with a lot of research on verification of each construct (Bostrom et al., 1990; Shih, 2003), supporting that study framework of education training did have the practicability. Based on research framework ideas of education training from Bostrom et al. (1990), the paper explores influence of target system, users' individual differences, and training methods on learning performance and output. The target system in this paper is Blog and the paper claims that Blog system environment characteristics and teaching strategies are affected by different learning styles, which further generate different learning performance.

2.3 Learning styles

Learning styles refer to special learning strategies in learning missions; i.e., the special preferences or nature of students using certain special learning strategies in unanimity in different conditions.

Kolb learning style theory

Learning style theory by Kolb (1976) is most widely used in the academic circle. Kolb's learning style scale combines theoretic foundation of Jung, Levin, Dewey and Piaget in wide application. The experience learning theory of Kolb (1984) is divided into two major dimensions: (1) concrete vs. abstract: information perception; (2) active vs. passive: information processing as in Figure 2.

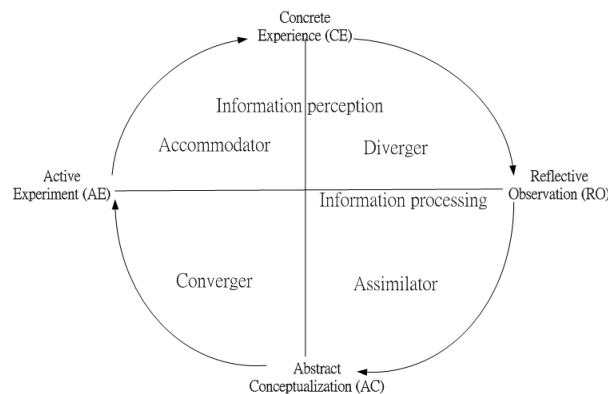


Figure 2 Experience Learning (Kolb, 1984)

Based on the two dimensions (information perception and information processing) and four learning forms (concrete experience, abstract ideas, passive observation, and active experiment), Kolb divided into four learning styles: diverger, assimilator, converger and accommodator.

1. Accommodator: fondness of AE and CE. The major characteristic is fondness of obtaining new experience through actual operation and completion of plans or missions to adapt to new environment easily. Learners quite depend on information from other people rather than their own analysis ability.
2. Diverger: fondness of RO and CE to learn through dimensions of scenarios with much observation and few activities. Learners tend to solve problems with imagination and feelings. They use pictures or overall ideas to help learning; they care about less theories or general principles. They like to learn from observing other people.
3. Converger: fondness of AE and AC. They are good at finding actual application of theories and solutions to problems to have knowledge through their own experiments. They are good at organizing knowledge in hypothesis-deduction and tend to handle technology problems better than social problems.
4. Assimilator: fondness of RO and AC. The characteristic is the ability of generalizing inference and establishing the theory models. They have ability of stronger generalizing inference and establishing theory models to assimilate observed objects into an entirety.

A great number of domestic and foreign scholars have adopted learning style scale of Kolb (1984) (Bostrom et al., 1990; Bozionelos, 1996; Sein and Robey, 1991; Rasmussen and Davidson, 1998; Wang, 2001; Shih, 2003). From literature, learning styles are important in learning process. In Blog system environment, the researcher explores whether different teaching strategies lead to different learning performance due to different learning styles.

3. Study model

3.1 Study process and constructs definition

Bostrom et al. (1990) held that mutual effects of target system, individual differences and training methods caused different learning results. Based on the theory framework, the study explores influence of teaching strategies and different learning styles on learning performance in Blog system. The research takes target system, individual differences and training methods in framework of Bostrom et al. as the major dimensions; target system is Blog system; training method is based on interaction strategies constructivism and scaffolding. Individual differences are categorized in accordance with learning styles by Kolb. The study model is as per Figure 3. Operative definitions of constructs are in Table 1. Learning effects covers learning satisfaction and learning performance. The research is in two stages. In the first one, survey study is used to understand Blog system quality, teaching strategies, learning performance and learning satisfaction. The second stage is experiment

design to understand differences of groups on variables. The experiment design is in quasi-experiment method to find out whether experiment group has enhanced learning performance under mutual influence of constructivism-and scaffolding-based teaching strategies and learning styles.

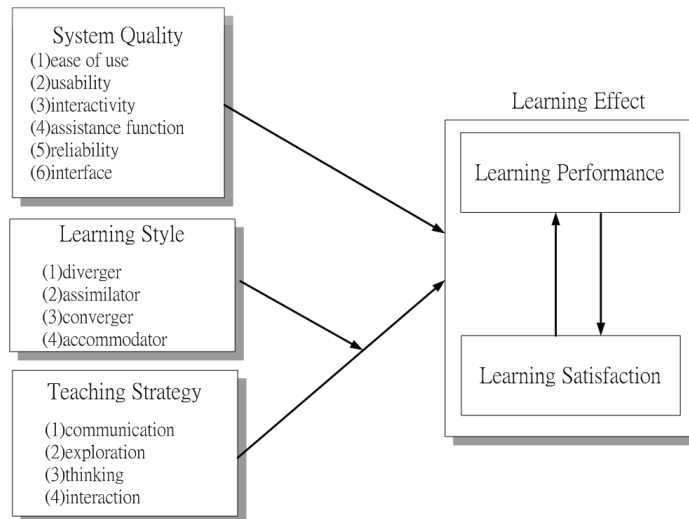


Figure 3 Research Model

Table 1 Operational Definition

Construct	Operational Definition
System Quality	This study considers system quality of Blog to be concerned with Ease of use, usability, interactivity, assistance function, reliability, and interface.
Teaching Strategy	The teaching strategy used in this study is based on Constructivism and scaffolding. The experiment group is conduct interaction strategy (control, feedback, and guidance).
Learning Style	There are four learning styles identified in Kolb’s theory (1984): Diverger, Assimilator, Converger and Accommodator. Each learning style emphasized in his theory is associated with different ways of learning and solving problems.
Learning Satisfaction	Learning satisfaction is defined as satisfied with learning processes in Blog environment.
Learning Performance	This study uses the score of term as learning performance, including: Early stage test, participating, oral report, and final score.

3.2 Theory association

The teaching strategies are based on constructivism and scaffolding. To begin, association between the two is explored and then explained in knowledge spiral to discuss association between theories and Blog system environment.

3.2.1 Association based on constructivism and scaffolding

The research proposes meaning generalization and association based on constructivism of Piaget (1928, 1932, 1970) and by Vygotsky (1962, 1978). The association is in three stages as in Figure 4.

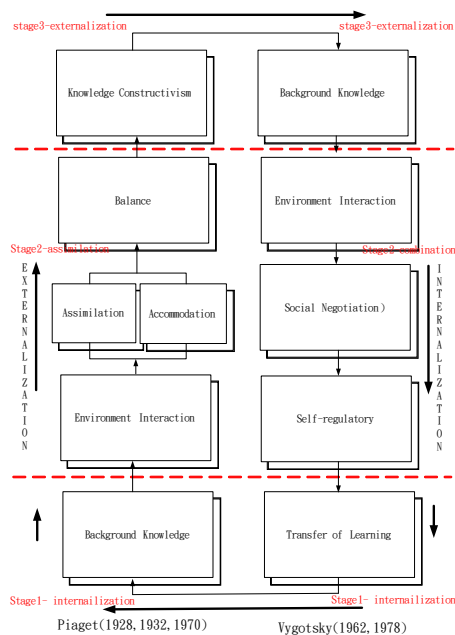


Figure 4 The Interrelationship Diagram of Constructivism and Scaffolding

3.2.1.1 Stage I: Learning internalization

In knowledge construction process, learners have interaction or contact with people, things and objects. Individuals create actual concepts, the individual background knowledge. Compared with scaffolding by Vygotsky (1978), under guidance by others and social negotiation, individual background knowledge has common consensus in interaction with environment. The mental process of internalize external social activities experience is the so-called internalization. After that, learners have new knowledge construction and eventually learning transfer.

3.2.1.2 Stage II: socialization and combination process

Learners compare the messages with schemes in their own cognitive structure in interaction with environment. With assimilation or accommodation, they attempt to combine the messages with original schemes. When new messages verify original schemes, assimilation is made; provided the new messages differ from original schemes, accommodation is made. Assimilation and accommodation reconcile the conflicts between new and old knowledge into balance. This stage equals to social negotiation and self-adjustment in scaffolding by Vygotsky (1962, 1978). In scaffolding, individual knowledge construction is the result of modification after interaction and negotiation with social environment. In Blog system, learners comprehend new knowledge through self-reflection and social interaction under others' guidance.

3.2.1.3 Stage III: learning externalization

Rogoff (1990), on Piaget (1928) constructivism, pointed out knowledge construction is under interaction of special individual background in use of mutual discussions to enhance development of individual concepts (Rogoff, 1990). As knowledge construction process allows mutual thinking, problem solving and decision making process, learners can obtain new knowledge. Vygotsky (1978) scaffolding claims that learning process leads potential development. Any high level mental function development starts with external social activities (e.g., interaction or contact among people and things). System concept development is mainly through experience of social interaction. In other words, thinking activities begin with intrapersonal process and then transferred to intrapersonal process. The study embeds the ideas of the two theories into Blog system so that learners with different backgrounds can present different learning tendencies and records.

3.2.2 Exploring constructivism and scaffolding in knowledge spiral

The research explores Piaget (1928) constructivism and Vygotsky (1978) scaffolding with knowledge spiral by Nonaka and Takeuchi (1995). Explanations of internalization and externalization are as Figure 5.

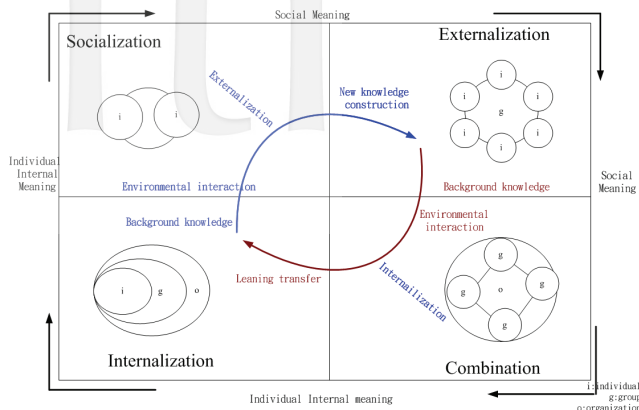


Figure 5 Spiral of Knowledge

3.2.2.1 *Internalization of knowledge learning*

In Vygotsky's scaffolding, all learning activities start with external social activities. In interaction between learners' background knowledge and environment, peers and teachers guide and social negotiation interact. Social activities experience is transferred into interpersonal process to have learning transfer. The process is like a spiral from individual and group externalization conceptual knowledge to social organization integration system knowledge and finally internalization operational knowledge.

3.2.2.2 *Externalization process of knowledge learning*

In Piaget's constructivism, learners take learning activities based on their background knowledge and ponder on original knowledge through assimilation and accommodation to reach knowledge socialization. The process is knowledge internalization of individuals as core-operational knowledge to socialization among people-sympathized knowledge and then to externalization of individuals and groups-conceptual knowledge.

With corresponding and combined theories (scaffolding, constructivism, and knowledge spiral), new things experiences from learning process lead to group knowledge externalization. Openness of Blog and accumulated Internet characteristics with unlimited external organizations complete knowledge combination spiral transference and self transcendence (Nonaka and Takeuchi, 1995) to reach: individuals→groups→organizations in the same meaning of Web Log→Blog→We Blog (Make We Blog) (Chao and Chang, 2005).

3.2.3 *Blog system based on constructivism and scaffolding*

Study results by Du and Wagner (2005) show that Blog is a construction learning tool with which students enhance learning performance. Ferdig and Tramell (2004)

pointed out feedback and quotation of Blog can be assisting tools of scaffolding. Learners can have self-study with their own learning styles in Blog environment. Figure 6 illustrates theoretic foundation and Blog environment:

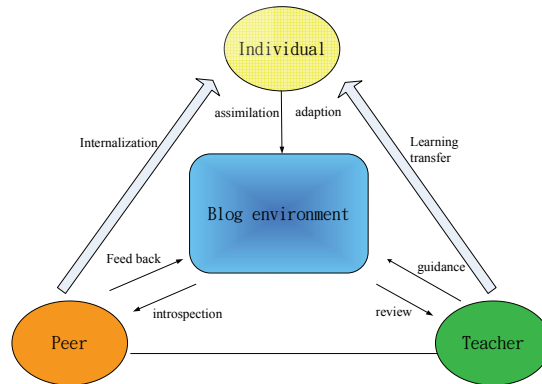


Figure 6 The Diagram of Blog Environment Based on Constructivism and Scaffolding

3.2.3.1 Support of constructive learning environment

Blog is a process of writing and recording when people adjust their judgment and text communication to proceed or express in their own ways. The process enhances learners' comprehension and use of knowledge. Quick release of Blog enables learners to combine their learning process and surrounding groups. In Blog system environment, learners review and examine what they wrote by reading their blogs to correct their comprehension deviations to have social construction in assimilation and accommodation.

3.2.3.2 Support of scaffolding assistance results

In Blog system environment, under assistance from teachers or peers with greater effects, learners enhance self-study and construction and train problem solving ability. In the process of guidance and feedback of teachers and peers and continual negotiation, learners have knowledge internalization and transfer.

4. Study hypothesis

In empirical survey of distance learning efficiency, Webster and Hackley (1997) pointed out that technology quality, trust and Internet transmission speed positively affect learning effects of students. Electronic learning environment is a medium to spread learning contents. In addition to required conditions of general system, rich and appropriate contents, sound functions and tools, friendly user interface and access free

will attract learners. Good user interface design is one of the factors that develop use efficiency and enhance learning effects. Higher learning willingness will also increase learning satisfaction (Amoroso and Cheney, 1991; Rivard, 1987). The research claims that Blog system quality will enhance learning performance and satisfaction.

H1a: Blog system quality positively affects learning performance.

H1b: Blog system quality positively affects learning satisfaction.

A great number of factors, such as learning styles, teaching methods and teaching resources, affect learning effects. Instructors are the key factor. The teaching strategies are to make learners participate in learning activities and improve learning effects in efficiency to reach the goal of teaching (Lee, 2006). Lam and Wong (1974) held that learning contents and methods that meet learners' interest or needs enhanced learning satisfaction. Appropriate teaching strategies enhance learning effects (Small and Gluck, 1994). Teaching strategies in this study are based on constructivism and scaffolding interaction in three stages of control, guidance and feedback. The experiment group was under such teaching strategies while comparison group was only under control strategies in Blog system environment but teachers did not get involved to explore whether learning effects could be improved without teaching strategies.

H2a: Teachers' interactive strategies based on constructivism and scaffolding (control, guidance and feedback) enhance learning performance.

H2b: Teachers' interactive strategies based on constructivism and scaffolding (control, guidance and feedback) enhance learning satisfaction.

In electronic learning, characteristics of learners affect the learning effects and are an issue to be discussed. Learners may have different learning effects from virtual environment, multimedia teaching materials, ability of using technology and learning styles. There are no good or bad learning styles. Under different training models, different training styles lead to different learning effects (Aliavi and Leidner, 2001; Bostrom et al., 1990; Davis and Davis, 1990). In Blog system environment, the paper explores influence of different teaching strategies and learning styles on learning effects. The researcher starts with Kolb learning styles theory. Assimilators and convergers are in abstract concept level. They think to learn from logic analysis and concepts. They take actions after understand the situation in systematic planning. They tend to ponder and observe in abstract concept. They prefer learning styles in positive direction and have stronger generalization inference so that they assimilate different opinions.

Convergers are fond of active experiment and abstract experience. They are good at organize knowledge in hypothesis and tend to handle technology problems than social problems. Therefore, they are good at find actual application of theory and problem

solutions to have knowledge through personal experiments. Learning scenario in this study is Blog learning. Convergers better handle technology problems and are willing to solve problems. Under teaching strategies, convergers better adapt to technology-oriented learning and feel positive on learning activities. The study infers that learning methods in which learning styles tend to be abstract (convergers and assimilators), under Blog learning environment and teaching strategies, learning performance and learning satisfaction will be higher than those of other learning styles learners.

H3a: Learning styles in abstract (assimilators and convergers), under constructivism and scaffolding interaction (control, guidance and feedback) influence, learning performance will be higher than that of other types of learners.

H3b: Learning styles in abstract (assimilators and convergers), under constructivism and scaffolding interaction (control, guidance and feedback) influence, learning satisfaction will be higher than that of other types of learners.

Learning performance are the index to measure learners' effect and one of the most important evaluation items in teaching quality. Learning performance are affected by learning types, course design and teaching (Kearsley, 2006); learning satisfaction is also one major factor to measure learning effects. Students' satisfaction can be affected by their personal factors, teachers, courses and learning environment. A lot of studies hold that learning satisfaction and learning performance are related (Zeithaml, Berry and Parasuraman, 1996). The paper claims that, once learners are more satisfied, in Blog system environment, they better enjoy such learning method and will have greater learning performance.

H4: Learning satisfaction has positive influence on learning performance.

H5: Learning satisfaction has positive influence on learning satisfaction.

5. Study methods

5.1 Study target

The study targets students at Department of Management Information Systems. Students in two classes (44 and 37 respectively) of EMBA are experiment group; 39 students in graduate class are comparison group. The dependent variable is learning performance and learning satisfaction. Students in two groups have different basic data (e.g., ages, learning motives) and there may be differences in their prior knowledge. Initial tests were given before experiment to understand the different of the prior knowledge. Test subject is Management Information System. Differences are under control.

5.2 Experiment design

Due to limit of classes, random distribution is not possible. With purposive sampling, the research adopts quasi-experimental research in non-random experiment comparison groups to collect data with two-factor quasi-experimental method. In the unit of classes, students are divided into experiment and comparison groups as in Table 2.

Table 2 Non-Randomized Control-Group Pretest-Posttest Design

Group	Number of Student	Pretest	Experiment Treatment	Posttest
Experiment	81	O1	X	O3
Control	39	O2		O4

Selection of classes may interfere with experiment. Differences of selecting classes are minimized. Three classes related to information management. Higher level information learning system and digital learning development and tendencies are in experiment group; distance education design and evaluation are in comparison group. Different teaching strategies in the two groups are in Table 3.

Table 3 The Learning Strategic of Experiment and Control Groups

Group	Class	Number	Stage 1	Stage 2	Stage 3
Experiment Group	Advanced IMS	44	Control	Feedback	Guidance
	Electronic Learning	37			
Control Group	Distance Education	39	Control		
Period			10/6-11/10 (6 weeks)	11/7-1/12 (8 weeks)	11/7-1/12 (8 weeks)

Note: IMS: information management system

The experiment group is under interactive strategies of constructivism and scaffolding in control, feedback and guidance stages. See Table 4 for actual interaction. In comparison group, control is given. Teachers only offer Blog learning platform without

getting involved. In experiment group, feedback and guidance strategies are given simultaneously in the purpose to whether interaction strategy based on constructivism and scaffolding enhances learning effects to compare the differences.

Table 4 The Classification of Interaction Strategic

Strategy	Conductor	Week	The Method of Interaction
Control	Teacher	1-6	1. application 2. downloadable material 3. writing comments
Feedback	Teacher Student	7-14	1. peers learn from each other 2. discuss on the comments 3. looking for feedback
Guidance	Teacher Student	7-14	1. active posting and talking 2. tutor and support 3. communication among peers 4. performance presentation

5.3 Teaching materials

Teaching materials include articles in academic journals on electronic learning. Each three weeks are one cycle. There are four themes to in a semester: (1) collaborative learning with computers as medium; (2) social learning theory; (3) non-synchronized electronic learning satisfaction; and (4) learning with Blog as the medium. Students are required to have learning on the platform of the institute. Requirements include:

1. Application of personal Blog at <http://163.23.9.171> and download of RssReader.
2. Students must academic materials on the articles to be read each week. Reports must be uploaded to personal Blog.
3. Articles to be read are available at teacher's Blog to be downloaded.
4. Comments and questions after reading articles will be uploaded on personal Blogs to be discussed by other students.
5. Mid-term and final examinations are based on topics discussed and comments on articles on the Blog.

5.4 Experiment process

Blog platform was first built. Each student had to register. Prior examinations were given to students in experiment group and comparison group to understand the differences in prior knowledge. For experiment group, constructivism and scaffolding-based interaction is teaching strategy; for comparison group, only Blog learning system environment is provided. Data were then gathered and evaluated. Learning record was reviewed with online situation in Blog system environment. Questionnaire was used to understand learning with Blog; learning effects were used as measurement index. See Figure 7 for experiment process:

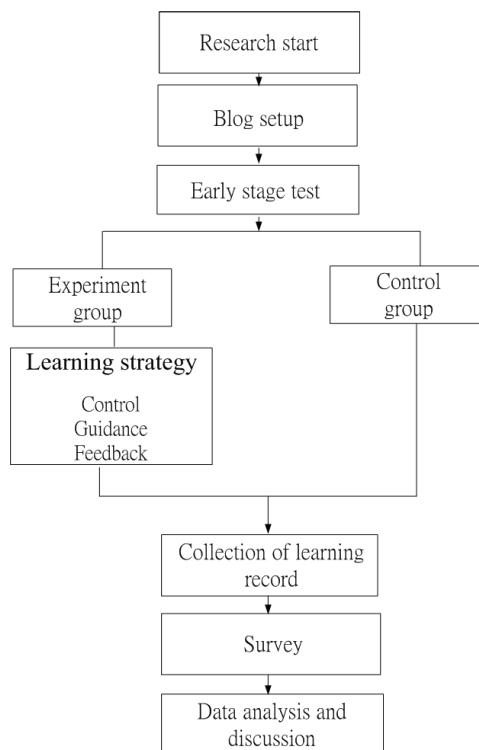


Figure 7 The Flow Chart of Experiment Design

5.5 Experiment situation and learning platform

Blog system environment meets characteristics of constructivism and scaffolding; it was used as the system platform. Blog in Plog 1.0.1 was used in Windows Server 2003. Open learning in Blog allowed interaction between learners and contents and learners and instructors as well among learners and learners with system interface. RSS (Really Simple Syndication) established exchange between teachers and peers for communication, exploration, thinking and interaction between teachers and students. Learning process was

enhanced. Blog system environment made learning process more diverse and interesting. See Figure 8 for Blog system environment structure and operation.

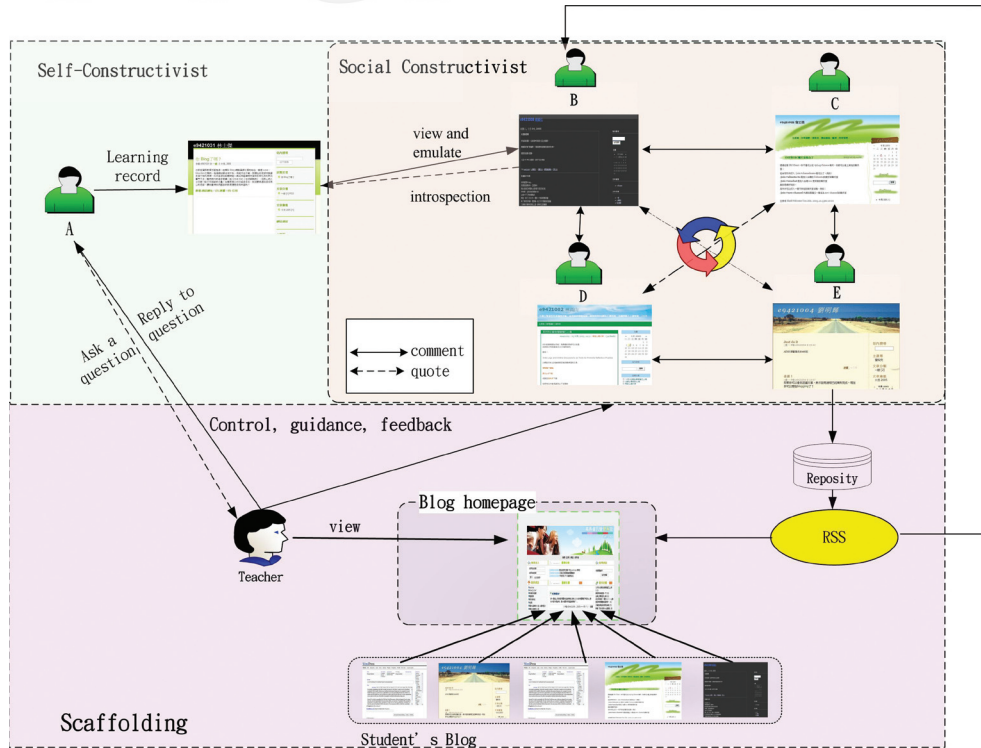


Figure 8 The Operational Mechanism of Blog

5.5.1 Self-constructivism

Learners kept record of what they learned on their Blog for self-study and knowledge management. With prior knowledge and available cognitive structure as well as new knowledge assimilation and accommodation, learners increased their knowledge. Blog system in this study provided learners with individual learning platform where learners kept record of their study on thesis papers, oral reports, and searched materials. The process helped growth of self-constructivism ability.

5.5.2 Social-constructivism

Social-constructivism emphasizes individual constructivism knowledge in social culture environment (Rogoff, 1990; Vygotsky, 1962, 1978). The openness and sharing of Blog allow learners to present, give feedback and quote to help them think and accumulate knowledge and ideas from peers to enhance their own knowledge.

5.5.3 Scaffolding

Learners have systematic learning record with management tool in Blog; quotation makes learners' Blog connected. Teachers and peers can give individual assistance based on the contents on the Blog.

6. Data analysis

Survey was made in questionnaire to students at graduate institute of management information system taking courses on electronic learning. Survey was made from 6 October 2004 to 12 January 2005. A total of 116 questionnaires were issued; there are 109 valid collected ones at the rate of 94%. Table 5 shows collection of questionnaires.

Table 5 The Rate of Recovery

Group	Send	Response	Response Rate	Invalid	Valid	Valid Rate
Experiment	81	79	98%	3	76	96%
Control	39	37	95%	4	33	89%
Total	120	116	97%	7	109	94%

Stage I: Causal relation among variables

6.1 Causal relation among system quality, teaching strategies, learning satisfaction and learning performance

1. With good system quality, learners had greater learning satisfaction ($p = 0.033 < 0.05$) and better learning performance ($p = 0.025 < 0.05$). This supports H1a and H1b as shown in Tables 6 and 7.
2. When learners perceived that teaching strategies were good, they had higher learning satisfaction ($p = 0.025 < 0.05$). This supports H2b. Learning performance were negatively affected ($p = 0.000 < 0.05$). H2a is not supported. Such phenomenon can be explained with experiment design, which was made in Tables 6 and 7.
3. As learning satisfaction gets higher, learning performance reduce ($p = 0.000 < 0.05$). H5 and H6 are not supported. To find out the reasons, the research made comparison between the two groups on learning satisfaction and learning performance. See Table 8 for details.

Table 6 The Regression Coefficients of Systems Quality and Learning Strategic on Learning Satisfaction

Construct	Standardized Coefficients	t	Sig.
	Beta		
Systems Quality	0.198	2.156	0.033
Teaching Strategy	0.649	7.062	0.000

Table 7 The Regression Coefficients of Systems Quality and Learning Strategic on Learning Performance

Construct	Standardized Coefficients	t	Sig.
	Beta		
Systems Quality	0.249	2.800	0.025
Teaching Strategy	-0.660	-4.769	0.000

Table 8 The Regression Coefficients of Learning Satisfaction on Learning Performance

Construct	Standardized Coefficients	t	Sig.
	Beta		
Learning Satisfaction	0.542	-6.655	0.000

Stage II: learning effects under mutual influence by learning styles and teaching strategies

In the first stage, teaching strategies posed negative influence on learning performance as well as learning satisfaction and learning performance. With experiment design, the research finds out the differences of variables and explores distribution of learners' learning styles, differences of experiment group and comparison group in learning effects and mutual effects of different learning styles and teaching strategies on learning effects.

6.2 Distribution of learning styles

From the scores of students in Kolb learning styles scale, learning styles distribution is made in Table 9 and Figure 9 to understand learning styles of the two groups (experiment group and comparison group).

Table 9 The Distribution of Learning Style on Experiment and Control Groups

	Learning Style							
	Accommodator		Diverger		Converger		Assimilator	
	N	%	N	%	N	%	N	%
Experiment (N = 76)	4	5.3%	6	7.9%	40	52.6%	26	34.2%
Control (N = 33)	7	21.2%	14	42.4%	8	24.2%	4	12.1%
Total	11	10.1%	20	18.3%	48	44.0%	30	27.5%

From the preceding table: (1) experiment group learners were mostly convergers (52.6%) and assimilators (34.2%) who tended to learn in abstract ideas (86.8%); (2) comparison group learners were mostly divergers (42.4%) and convergers (24.2%).

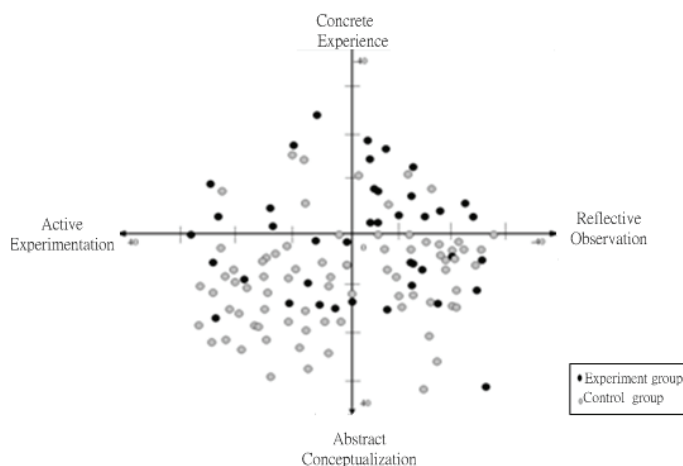


Figure 9 The Distribution of Learning Style on Experiment and Control Groups

6.3 Differences among learners in experiment group and comparison group on learning satisfaction and learning performance

6.3.1 Differences in learning effects of experiment group and comparison group

Independent sample t-Test was used to analyze the differences. From Table 10, experiment group and comparison group show significant differences in learning satisfaction ($p = 0.000 < 0.001$) and learning performance ($p = 0.000 < 0.001$). This means that, after experiment operation, experiment group had greater learning satisfaction and learning performance than comparison group.

Table 10 The Difference of Experiment and Control Groups on Learning Effects

Construct	t-Test for Equality of Means		
	T	p	Outcome
Learning Satisfaction	-4.817	0.000	Sig.
Learning Performance	-4.375	0.000	Sig.

6.4 Results of mutual effects of learning styles and teaching strategies

Learners with different learning styles have different learning effects under teaching strategies; MANCOVA was used as a result. Scores of prior tests were covariance to exclude influence of prior knowledge of the two groups. In MANCOVA, interactive effects among factors had to be considered. If it was significant, simple major effect test had to be made to compare differences of averages of each grid. If not, post comparison was made on main effect of factors (Wu Minglong, 2001). The research explores mutual effects of teaching strategies and learning styles on learning effects.

6.4.1 Learning performance

The results of multifactor covariance analysis in Table 11 showed interactive effects of groups (experiment group and comparison group) and learning styles were in significance level in learning performance ($F = 2.956, p = 0.036$). See Figure 10 for interactive effects.

Table 11 The Result of MANOVA on Learning Performance between Groups and Learning Style

Source of Variation	Sum Square	df	Mean Square	F	Sig.
Group	95.466	1	95.466	13.403***	.000
Learning Style	42.763	3	14.254	2.001	.119
Group X Learning Style	63.173	3	21.058	2.956*	.036

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

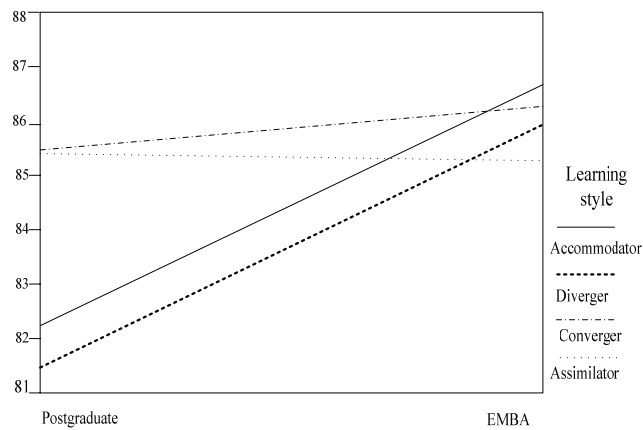


Figure 10 The Interaction of Groups and Learning Style on Learning Performance

Comparison was then made on adjusted average of grids. From Table 12, under interactive effects of teaching strategies and learning styles, experiment group learners had greater learning performance than those in comparison group.

Table 12 The Adjusted Marginal Mean of Learning Performance between Groups and Learning Style

		Group	Control Group	Experiment Group
			Adjusted Means	Adjusted Means
Learning Style	Accommodator		82.356	86.951
	Diverger		81.542	86.314
	Converger		85.568	86.527
	Assimilator		85.476	85.830

After exclusion of covariance (scores of prior test) influence, groups and learning styles had interactive effects on learning performance; that is, teaching strategies and learning styles affected learning performance. Due to results of interactive effects, simple main effect test on groups and learning styles had to be made as in Table 13.

Table 13 The Simple Main Effects of Groups and Learning Style on Learning Performance

Source of Variation	Adjusted Sum Square	df	Adjusted Mean Square	F	Post Hoc Comparison
Group (A)					
B1 (Accommodator)	65.44	1	65.44	9.19**	Experiment > Control
B2 (Diverger)	160.90	1	160.90	22.59***	Experiment > Control
B3 (Converger)	37.74	1	37.74	5.30*	Experiment > Control
B4 (Assimilator)	5.58	1	5.58	.78*	Experiment > Control
Learning Style (B)					
A1 (Control)	161.47	3	53.82	7.56***	Converger > Accommodator Assimilator > Accommodator Converger > Diverger Assimilator > Diverger
A2 (Experiment)	33.44	3	11.15	1.57	

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Simple major effects of group factor in each learning style were significant. As two groups did not have equal number of students. Scheffe's method was used for post comparison. The results showed experiment group surpassed comparison group. Under control of learning styles variable, comparison group learning style was convergers (M

= 85.568); assimilators' (M = 85.476) learning performance were better than those of accommodators (M = 82.356); convergers (M = 85.568) and assimilators (M = 85.476) did better than divergers (M = 81.542). H3a is supported.

6.4.2 Learning satisfaction

From Table14, interactive effects of groups and learning styles was in significance level in learning satisfaction variable ($F = 2.746$, $p = 0.047$). Learners in experiment group and comparison group under interactive effects of different teaching strategies and different learning styles had different learning satisfaction. See Figure 11 for interactive effects.

Table 14 The Result of MANOVA on Learning Satisfaction between Groups and Learning Style

Source of Variation	Sum Square	df	Mean Square	F	Sig.
Group	40.159	1	401.159	7.340**	.008
Learning Style	91.968	3	30.656	5.603**	.001
Group X Learning Style	45.081	3	15.027	2.746*	.047

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

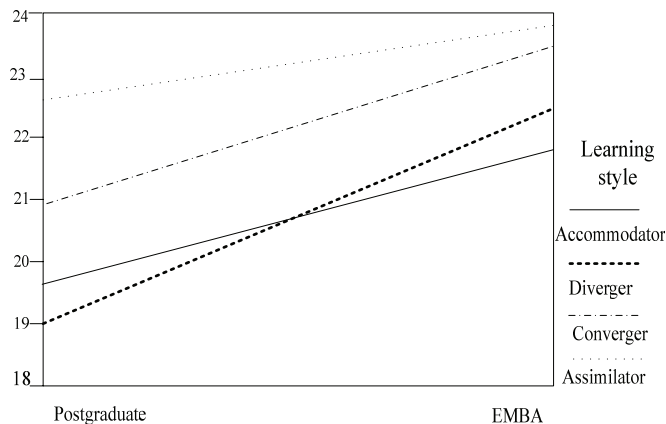


Figure 11 The Interaction of Groups and Learning Style on Learning Satisfaction

From Table15, under interactive effects of groups and learning styles, experiment group learners had greater learning satisfaction than those in comparison group.

Table 15 The Adjusted Marginal Mean of Learning Satisfaction between Groups and Learning Style

Learning Style \ Group		Control Group	Experiment Group
		Adjusted Means	Adjusted Means
Learning Style	Accommodator	19.537	21.654
	Diverger	18.927	22.491
	Converger	21.913	23.301
	Assimilator	22.759	23.521

After exclusion of covariance influence, groups and learning styles had interactive effects on learning satisfaction. Learners in experiment group and comparison group under interactive effects of different teaching strategies and different learning styles had different learning satisfaction. Simple major effect test was made on groups and learning styles as in Table16.

Table 16 The Simple Main Effects of Groups and Learning Style on Learning Satisfaction

Source of Variation	Adjusted Sum Square	df	Adjusted Mean Square	F	Post Hoc Comparison
Group (A)					
B1 (Accommodator)	21.95	1	21.95	4.01*	Experiment > Control
B2 (Diverger)	98.10	1	98.10	17.93***	Experiment > Control
B3 (Converger)	62.04	1	62.04	11.34**	Experiment > Control
B4 (Assimilator)	22.08	1	22.08	4.04*	Experiment > Control

Table 16 The Simple Main Effects of Groups and Learning Style on Learning Satisfaction (Continue)

Source of Variation	Adjusted Sum Square	df	Adjusted Mean Square	F	Post Hoc Comparison
Learning Style (B)					
A1 (Control)	157.82	3	52.61	9.61***	Assimilator > Accommodator Converger > Diverger Assimilator > Diverger Assimilator > Converger
A2 (Experiment)	67.37	3	22.46	4.10**	Converger > Accommodator Assimilator > Accommodator

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

From simple major effect analysis of groups and learning styles on learning satisfaction, under comparison group variable and control of group variable, four learning styles had significant differences in learning satisfaction under Blog. From post comparison in Scheffe's method, experiment group surpassed comparison group. Under control of learning style variable, experiment group and comparison group learning styles are assimilators and convergers who felt satisfied in Blog learning. H3b is supported.

7. Analysis and discussions

7.1 Differences of learning styles on learning effects

1. Learners in experiment group preferred learning in AC. Assimilators and convergers had the highest learning satisfaction in AC learning. Accommodators and convergers had better learning effects in AE learning. Such learners often had ability of turning ideas into practice. When facing problems, they tried hard to solve them.
2. Learners in comparison group tended to have CE learning; convergers and assimilators had highest learning satisfaction and learning performance. The two were prone to AC learning.

3. Major effect of learning styles in learning performance was not significant. Under teaching strategies mutual effects, it became significant. Learning styles did not show differences in learning performance. Under teaching strategies interactive effects, experiment group and comparison group did show significant differences; experiment group' learning satisfaction and learning performance were higher than those of comparison group.

Results in this study show that learning styles did have significant influence on learning satisfaction. From Kolb's learning styles theory, assimilators, fond of thinking and generalization, preferred learning in specific direction and had stronger ability of generalization and inference and establishing theory structure. They could assimilate different opinions and more easily adapted to the environment. Their learning satisfaction was higher than that of other learners. In learning performance, accommodators and convergers in experiment group had higher learning performance. The two kinds of learners preferred active experiments and were good at learning by doing. They better completed things and liked to complete projects or missions to have new experience.

In the two dimensions of *concrete experience/abstract experience* and *active experiment/thinking and observation*, learners prone to concrete experiment and active experiment had better learning performance. Learning tool in the study was Blog system environment; electronic learning environment required active participation of learners. Therefore, accommodators preferring active experiment and concrete experience had better learning performance. The result corresponds to the study by Rasmussen and Davison-Shivers (1998).

7.2 Teaching strategies with scaffolding and constructivism did enhance learning effects

From Table13 and Table16 on major effects of learning performance of experiment group and comparison group, experiment group students, after receiving teaching strategies, had significantly higher learning satisfaction and learning performance than those in comparison group. The advantages of constructivism and scaffolding in Blog environment enabled learners to accumulate knowledge, have feedback, interaction, exchange, guided learning, and thinking. Learners surpassed those in comparison group. Reason of different satisfaction is experiment group learners were guided by teachers and classmates to lead to higher learning satisfaction.

7.3 Under interactive effects of teaching strategies and learning styles, experiment and comparison groups caused different learning effects

Earlier studies focused on learning styles or learning modes' single major effect and ignored interactive effects of learning styles and learning models on learning performance.

Based on Kolb's learning style theory in empirical analysis, the research found teaching strategies and learning styles interactive effects had significant difference on learning satisfaction and learning performance. In testing learning performance, major effect of learning styles was not significant ($F = 2.001$, $p = 0.119$). There were no significant differences between experiment group and comparison group. After experiment manipulation, interactive effects of groups (experiment group and comparison group) and learning styles in learning performance ($F = 2.956$, $p = 0.036$) are significant (Table 11). Learners with different learning styles, after experiment, had significant differences; experiment group's learning performance was higher than comparison group (Table 12). In learning satisfaction, learning styles major effects had significant results from the beginning ($F = 5.603$, $p = 0.001$), meaning that experiment group and comparison group learners had differences in earlier learning satisfaction. After exclusion of covariance influence, mutual influence by teaching strategies learning styles led to different learning satisfaction (Table 13). From Table 16, experiment group surpassed comparison group in learning satisfaction. The results showed that experiment group, receiving scaffolding and constructivism learning and under teaching strategies, did have greater learning satisfaction and learning performance. The results correspond to those of Bostrom et al. (1990) and Yu (2003). Learners with different learning styles under different teaching strategies had different learning effects.

8. Conclusions and suggestions

General conclusions are given on data analysis results. Suggestions are proposed to instructors using Blog system environment in the future as reference for ensuing research.

8.1 Study concrete

Experiment group receiving interactive strategies had better learning effects than those in comparison group. Help from teachers and peers did enhance learning effects. The Blog system environment in the research had rich and appropriate function modules to promote knowledge accumulation, feedback, interchange, and guided learning. It was proven that this information technology in education did enhance learning effects. Information itself does not create values. It requires guidance of teaching strategies and use of learners. Design of teaching is also the key factor of good learning effects.

Learners have different learning styles. Appropriate instruction in group or independent research activities has learners influence one another or think independently to exchange experience. It is believed this will achieve good learning effects in the best learning ways. Learning styles can serve as guidelines for students' learning experience (Claxton and Murrell, 1987) and help teachers understand students' behaviours and needs.

Students can understand their own learning styles for appropriate adjustment to have best learning effects. An appropriate learning environment in which students have learning motive in autonomous exploration will make learning a substantially helpful activity (Lawrence, 1984).

8.2 Study suggestions

1. Learning styles only focus on personal differences but not division of good and bad. Teachers shall provide appropriate instruction based on individual differences of students. Measurement of learning styles can be made at beginning in division different groups. Learners with great difference in cognitive level are in one group so that they can be mutually complementary for learning exchange. This will prove ZPD theory of Vygotsky (1978).
2. Blog and wiki are currently popular composition tools on the Internet. Sharing and feedback free from limitation of time and space is one major characteristic. Future instructors can make use of them for collaborative learning and mutual composition practice.

References

1. Alavi, M. and Leidner, D.E. (2001) 'Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues', *MIS Quarterly*, Vol. 25, No. 3, pp. 107-136.
2. Amoroso, D.L. and Cheney, P.H. (1991) 'Testing a causal model of end-user application effectiveness', *Journal of Management Information Systems*, Vol. 8, No. 1, pp. 63-89.
3. Bodner, G.M. (1986) 'Constructivism: A theory of knowledge', *Journal of Chemical Education*, Vol. 63, No. 10, pp. 873-878.
4. Bostrom, R.P., Oliman, L. and Sein, M.K. (1990). 'The importance of learning style in end-user training', *MIS Quarterly*, Vol. 14, No. 1, pp. 101-119.
5. Bozionelos, N. (1996) 'Cognitive spontaneity and learning style', *Perceptual and Motor Skills*, Vol. 83, pp. 43-48.
6. Chao, R.M. and Chang, Y. T. (2005) 'The study of collaborative interaction model based on Wiki', *IITM*, pp. 145-152.
7. Chang, S.C. (1997) 'Constructivism and science teaching', *Science Education Monthly*, Vol. 202, pp. 17-25.

8. Clasen, R.E. and Bowman, W.E. (1974) 'Toward a student-centered learning focus inventory for junior high and middle school teacher', *Journal of Educational Research*, Vol. 68, No. 1, pp. 9-11.
9. Claxton, C.S. and Murrell, P.H. (1987) 'Learning styles: Implications for improving educational practice', ASHE-ERIC Higher Education Report, Vol. 4, George Washington University, Washington, DC.
10. Davis, D.L. and Davis, D.F. (1990) 'The effect of training techniques and personal characteristics on training end users of information systems', *Journal of Management Information System*, Vol. 7, No. 2, pp. 93-110.
11. Du, H.S. and Wagner, C. (2005). 'Learning with weblogs: An empirical investigation', *Proceedings of the 38th Hawaii International Conference of System Sciences*, pp. 1-9.
12. Felder, R.M. and Brent R. (1996) 'Navigation the bumpy road to student-centered instruction', *College Teaching*, Vol. 44, No. 2, pp. 43-47.
13. Ferdig, R.E. and Trammell, K.D. (2004) 'Content delivery in the blogosphere', *T.H.E Online Journal*, Vol. 31, No. 7.
14. Freitag, E.T. and Sullivan, H.J. (1995) 'Matching learner preference to amount of instruction: An alternative form of learner control', *Educational Technology Research & Development*, Vol. 43, No. 2, pp. 5-14.
15. Jones, E.K., Sullivan, H.J. and Klein, J.D. (1996) 'The effects of matching learning preference for instructional method on achievement and attitude', *18th National Convention of the Association for Educational Communications and Technology*, Indianapolis, IN.
16. Kearsley, Greg. (2006) 'Criterion Referenced Instruction. In Explorations in Learning and Instruction: The Theory into Practice Database', 3 March, <http://www.gwu.edu/~tip/index.html>
17. Kolb, D.A. (1984) *Experiential Learning: Experience as the Source of Learning and Development*, Prentice Hall, New York.
18. Kolb, D.A. (1976) Learning Style Inventory, *Technical Manual*, McBer and Company, New York.
19. Lam, Y.L.J. and Wong, A. (1974) 'Attendance regularity of adult learners: An examination of content and structural factors', *Adult Education*, Vol. 24, No. 2, pp. 130-142.
20. Lawrence, G. (1984) 'A synthesis of learning style research involving the MBTI', *Journal of Psychological Type*, 8, pp. 2-15.

21. Lee, L.S. (2006) *The Issue of Technology and Professional Education*, Shtabook.
22. Meyer, C.A. (1992) 'What's the difference between authentic and performance assessment?', *Educational Leadership*, Vol. 49, No. 8, pp. 39-40.
23. Mitchell, D. (2005) 'Thoughts about Blogs in Education', 27 March, [http://www.technology.org/stories/storyReader\\$150](http://www.technology.org/stories/storyReader$150)
24. Nonaka, L. and Takeuchi, H. (1995) *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press, New York.
25. Nang, C.H. (2001) 'A study of the learning behaviour, satisfaction and performance on internet learning', *Master Thesis of Da-Yeh University*, Changhua.
26. Okebukola, P.A. (1986) 'The influence of preferred learning styles on cooperative learning in science', *Science Education*, Vol. 70, No. 5, pp. 509-517.
27. Osborne, R.J. and Wittrock, M.C. (1983) 'Learning science: A generative process', *Science Education*, Vol. 67, No. 4, pp. 489-508.
28. Piaget, J. (1928) *Judgment and Reasoning in the Child*, London.
29. Piaget, J. (1970) *Piaget's Theory. Carmichael's of Child Psychology*, Wiley, New York.
30. Piaget, J. (1932) *The Moral Judgment of the Child*, London.
31. Rasmussen, K.L. and Davidson-Shivers, G.V. (1998) 'Hypermedia and learning styles: Can performance be influenced?', *Journal of Education Multimedia and Hypermedia*, Vol. 7, No. 4, pp. 291-308.
32. Reynolds, R. (2004) 'Trend Repot', 27 March, <http://www.xplanazine.com/>
33. Rivard, S. (1987) 'Successful implementation of end-user computing', *Interfaces*, 17, pp. 25-33.
34. Rogoff, B. (1990) *Apprenticeship in Thinking: Cognitive Development in Social Context*, New York.
35. Sein, M.K. and Robey, D. (1991) *Learning Style and the Efficacy of Computer Training Methods*, McGraw-Hill, New York.
36. Small, R.V. and Gluck, M. (1994) 'The relationship of motivational conditions to effective instructional attributes: A magnitude scaling approach', *Educational Technology*, Vol. 34, No. 10, pp. 33-40.
37. Von Glasersfeld, E. (1984) *Introduction to Radical Constructivism*, Norton, New York.

38. Shin, H.J. (2003) 'The study on the combination of learning style and approach for examining learning performance -- Based on interactive or non-interactive', *Master Thesis of Chung Yuan Christian University*, Taoyuan.
39. Vygotsky, L.S. (1978) *Mind in Society: The Development of Higher Psychological Processes*, Knox and Carol, Trans., Harvard Business School Press, Cambridge, MA.
40. Vygotsky, L.S. (1962) *Thought and Language*, Cambridge, MA.
41. Wagner, C. (2003) 'Put another (B)log on the wire: Publishing learning logs as blogs', *Journal of Information Systems Education*, Vol. 14, No. 2, pp. 131-132.
42. Webster, J. and Hacklery, P. (1997) 'Teaching effectiveness in technology mediated distance learning', *Academy of Management Journal*, Vol. 40, No. 6, pp. 1282-1309.
43. Yu, F.Y. (2003) 'The learning effects of instructional methods and learning preferences in a computer-assisted science learning environment', *Bulletin of Educational Research*, Vol. 49, No. 4, pp. 251-273.
44. Zeithaml, V.A., Berry, L.L. and Parasuraman, A. (1996) 'The behavioural consequences of service quality', *Journal of Marketing*, Vol. 60, No. 2, pp. 31-46.

About the authors

Jamie Y.T. Chang is a Ph.D. candidate at the Department of Information Management, National Central University, Taiwan (ROC). Her research interests include knowledge management, organizational learning and IS project management.

Eric T.G. Wang is Information Management Chair Professor at National Central University, Taiwan (ROC). He received the Ph.D. degree in Business Administration, specialized in computer & information systems, from the William E. Simon Graduate School of Business Administration, University of Rochester. His research interests include electronic commerce, outsourcing, organizational economics, organizational impact of information technology, inter-organizational information systems and supply chain. His research has appeared in *Information & Management*, *Management Science*, *Information Systems Research*, *Journal of Management Information Systems*, *Decision Sciences*, *Decision Support Systems*, *Information Systems Journal*, *Omega*, *European Journal of Information Systems*, *European Journal of Operational Research*, *International Journal of Information Management*, and others.

Ruey-Ming Chao is Assistant Professor in the Graduate Institute of Information and Social Science at National United University (NUU), Taiwan R.O.C.. He received his Ph.D. degree in Management Information Systems, from the School of Computer and Information Science at Nova Southeastern University, USA in 1999. His research interests include the general area of Knowledge Intensive Business Services (KIBS), Behaviour Science in Human and Computer Information Systems, and Digital Learning System Development & Management. In particular, currently, he is interested in the realms of digital learning, the development model, and strategy of knowledge reuse to the enterprises.