The Framework for Development of Constructivist Web–Based Learning Environment Model to Enhance Mechanism and Critical Thinking for Undergraduate Students

Naritsara Loiypha and Sumalee Chaijaroen[*]

Department of Educational Technology, Faculty of Education, Khon Kaen University

[*]Corresponding author sumalee@kku.ac.th

Abstract

The purpose of this research is to develop a framework of Constructivist web-based learning environment model to enhance undergraduate students' mechanism and critical thinking. Model research was employed in this study (Richey & Klein, 2007), which focuses on processes of design and model development. The research procedures consist of three major steps: 1) document analysis and examination of learning and teaching context, 2) analyzing related principles and theories such as learning theory, Constructivist theories, Critical thinking, media theory and technology, and 3) synthesizing the theoretical framework and desingning framework for Constructivist web-based learning environment model to enhance mechanism and Critical thinking. The participants of this study were experts from various fields such as theorists, designers, developers, evaluators, researchers, and learners. The results of the study show that there are five basic elements of the theoretical framework, which are psychological base, pedagogical base, contextual base, technological base, and media symbol system base. The designing framework consisted of four stages are as follows: 1) the activation of cognitive structure and to enhance Critical thinking, 2) the support and enhancement of knowledge construction, 3) the enhancement of cognitive structure and Critical thinking, 4) the Encouragement and support of knowledge construction and learning performance and 6 elements as following: 1) Problem base, 2) Resources, 3) Collaboration, Coaching, 4) Critical thinking Lab, 5) Scaffolding, and 6) Cognitive Tools.

Keywords: Web-Based Learning, constructivist, Constructivist Web-Based Learning, Critical thinking, Mechanism, Mechanism of critical thinking

■■ Introduction

In the era of economic community with a variety of ethnics, cultures, languages, and high competition in every aspect, there have been changes in society, economy, politics, and technology and communication as well as the diversity of cultures of other countries (Bureau of International Relations, 2013). Human resources are the most important resources in developing countries along with the economic growth. Professional skills and communication skills can help promote lifelong learning, which is substantially vital. Importantly, in the 21st century, which is the era of the knowledge-based society. The advancement of technology, machinery, electronic instruments, communication without limitations, and a variety of information services have considerable impact on the economy, society, politics, life situation, and higher social competition. To complete in such new changing society, human resources are the most important resource. Students will confront with variety of information that has both enormous advantages and disadvantages. To be able to live in this changing world, students must be able to evaluate the information. They should be able to decide what to believe and not to believe, and they can make decisions or solve problems in various situations in their life or the world of reality. To be able to evaluate information effectively and to keep pace with changes in technology and information, they need to have Critical thinking. According to the results of TIMSS and PISA,

Thai students' Critical thinking ability was low (National Institute of Educational Testing Service [NIETS], 2008; The Institute for the Promotion of Teaching Science and Technology [IPST], 2009). As such, Thailand's educational system needs to be improved in order to efficiently promote students' ability to think critically. This indicated that the educational problem exists in the educational system of Thailand, undoubtedly starting from the primary level, which subsequently impacts the teaching management at a higher education level.

To develop human resources' potential to possess ability to live in the age of technological changes with information overload and to be able to compete with other countries, an education reform is needed. Currently, a paradigm of teaching management has been shifted to a learner-centered learning approach in which learners are encouraged to be active learners, think critically, and search for information to construct the knowledge to construct the knowledge by interacting with various learning resources such as teachers, local wisdom, and so on (Chaijaroen, 2008). The important approach proposed to promote the learnered-center is Constructivist Theory, which promotes knowledge construction through solutions in the authentic by interacting with the learning environment. The instructor's role is changed, and his/her role is to support the learning of students and to encourage students to think reasonably and to have critical thinking, which are needed to be promoted in the process of learning and studying skills to support thinking process (Cognitive Process).

Results from previous studies showed that internal factors such as prior knowledge enhanced students' understanding of real world problems. The findings are consistent with the Constructivist Theory, which is also known as knowledge construction (Chaijaroen, 2014). This approach is consistent with the guidelines of the National Education Act that students must be able to create knowledge by themselves (Office of the National Education Commission, 2002) and Critical thinking.

In addition, the Education Act 1999, in particular Chapter 9 Technology for Education from section 63 to section 69 states that it is vital to promote the use of technology for education in order that the people of Thailand can learn and develop themselves continuously throughout life. Therefore, the teaching and learning management in education is necessary to use the computer in various teaching and learning aspects, a model of learning environment development is one of innovations which brings media attribution and media symbol systems that respond to learning anytime and anywhere.

The growth of technology and communication on the internet will be the study of media symbol systems consistent with the construction of knowledge and the promotion of ideas and solutions and Critical thinking. Moreover, studying on the web-based learning with the use of the media symbol systems as hypertext, hyperlink and hypermedia presented in animations, graphics, text, and sound, including hyperlink can be interconnected nodes of knowledge all over the world helps expand knowledge construction of learners as well. The symbol system which is used to transfer knowledge of the media affects the understanding of each different student (Chaijaroen, 2004; Kozma,1991). The characteristics of the media can help facilitate students' collaboration on problem solving and multiple perspectives that promote and expand their cognitive structure. In addition, learners are the constructors of their own knowledge through creating their own ideas and seeking a wide range of information to solve problems (Chaijaroen, 2008; Hannafin, Susan, & Kevin, 1999; Rovai & Jordan, 2004; Jonassen & Henning, 1999; Solomon & Clark ,1977).

Based on the aforementioned reasons and the vital features of the media symbol system, the researchers, thus, recognize the importance of bringing media innovations into the research in order to achieve the objectives of this present study and to facilitate the instructor's teaching in order for him/her to have high quality instructional technology and innovations

for future teaching and learning, through which learners can construct the knowledge by themselves anytime and anywhere (learn for all: anyone, anywhere and anytime). This current research also aims to promote learner autonomy in which learners can learn at their own pace by using a web-based learning environment model developed based on the synthesis of previous literature on knowledge construction, problem solving, Critical thinking, the promotion of students' knowledge construction, the development of the Critical thinking, and the development of technology and media. It is expected that the model can be used as an educational guideline in future research and that it is beneficial for developing the Critical thinking of the learners in the future.

▰▰ Methodology

This research is the first phase of the Model research (Richey & Klein, 2007), which focuses on the design process and model development. The process consists of 1) document analysis examine the learning, teaching and context, 2) analyze related principles and theories such as learning theory, Constructivist theory, Cognitive theory, Critical thinking, media theory, and technology, designing of Constructivist web-based learning environment model to enhance mechanism and Critical thinking, 3) synthesize the theoretical framework. The participants in this phase included experts from various fields such as theorists, designers, developers, evaluators, researchers, and learners. The Model research on the first phase is the Model development. The data were collected by quantitative and qualitative methods. The document analysis and survey were used.

Research Instruments
Data collection instruments

1. A synthesis of theoretical framework record form for recording the analysis of document and related research.

2. An open-ended survey on students' opinions about the context of learning teaching. Questions are concerned with teaching and studying that can promote Critical thinking.

3. A synthesis designing framework record form for recording the analysis of document and related research for designing the learning environment model.

4. The reviewed record form for checking the quality of the designing framework.

5. An open-ended survey of the participants' characteristics adapted from Richey and Klein (2007).

6. An interview formfor the designer and the developer on the design and development processes of the learning environment model, adapted from Richey and Klein (2007).

Data Collection

The data were collected as the following details:

1. Document analysis.The researcher reviewed and analysed principles, theories, and previous research studies on the web-based learning environment model, which consisted of a variety of fundamentals such as Psychological base, Pedagogical base, Media theory base, Technological base, and Contextual base. Based on the synthesis of these principles and theories, the theoretical framework for model development was developed.

2. Synthesis of the theoretical framework. The framework was obtained from the analysis of related documents and related researcher as mentioned above. After that, they were recorded by using the synthesis of theoretical framework record form.

3. Survey of students' opinions. The students' opinions on learning and teaching context were examined by using open-ended survey on students' opinions about the context of learning teaching.

4. Synthesis of the designing framework, which was based on the theoretical framework and the contextual study of learning and teaching. The data were collected by using the recording form for synthesis of the designing framework.

5. Exploring of the characteristics of the

designers, the developers, instructors and learners by using open-ended survey of the participants' characteristics and the development of the learning environment model by using the interview form for the designer and the developer.

Data analysis

1. To obtain the theoretical framework, related principles and theories and documents were analyzed and synthesized by using summarization,interpretation and analytical description.

2. The students' opinions concerned the learning and teaching context from the opinionniare were analyzed by using summarization,interpretation and analytical description.

3. The designing framework was analyzed by using summarization, interpretation and analytical description.

4. The experts' assessment concerning the designing of the learning environment model was analyzed by using summarization,interpretation and analytical description.

5. The characteristics of the participants for designing and developing the web-based learning environment model were analyzed by using summarization, interpretation and analytical description.

■■■ **Results of the study**

The results of this study are as follows:

Theoretical framework

The results revealed that the theoretical framework consists of 5 fundamental: 1) Psychological base, 2) Pedagogical base, 3) Contextual base, 4) Technological base, and 5) Media symbol system base (see Figure 1).
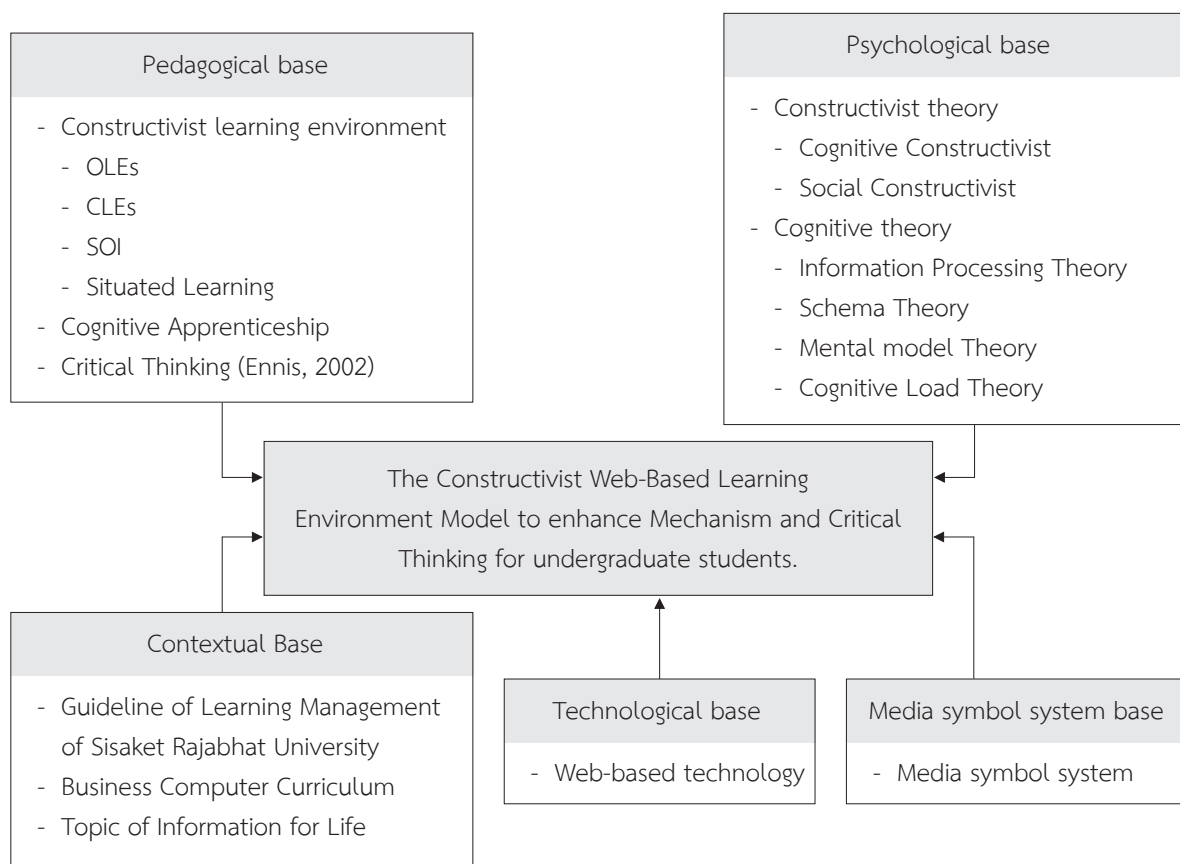

Figure 1 The Theoretical Framework of the Constructivist Web-Based Learning Environment Model to Enhance Mechanism and Critical Thinking for Undergraduate Students

Designing a framework of web-based learning environment model

The designing framework of Constructivist web-based learning environments model to strengthen students' mechanism and Critical thinking showed the four stages as follows:

1. The activation of cognitive structure and to enhance Critical thinking. The activation of cognitive structure states the importance of the relationship between different underlined theories, which include Constructivist theories and Cognitive constructivist theory (Piaget, 1965), CLEs model (Jonassen, 1999), Situated learning (Brown, Collins, & Duguid, 1989), and Critical thinking (Ennis, 2002). It was designed on complex problem context as the component of Problem base.

2. The support and enhancement of knowledge construction. Five theories must be taken into considerations when designing a web-based learning model to support and enhance students' knowledge construction. These include Cognitive load theory (Sweller, 1994), SOI Model (Brown et al., 1989), Information processing theory (Klausmeier, 1985) Schema theory (Anderson, 1990; Smith, 1989) and Mental model (Merrienboer,1997). It was designed as the component of Resources.

3. The Enhancement of cognitive structure and Critical thinking. To enhance cognitive structure and Critical thinking, the relationship between the following underlined theories must be adopted. These include Social constructivism (Vygotsky, 1962), Collaboration OLEs (Hannafin et al., 1999), and Critical thinking (Ennis, 2002). It was designed as the component of Critical thinking lab.

4. The encouragement and support of knowledge construction and learning performance (e.g., Critical thinking). The relationship between the following underlined theories must be achieved. These include OLEs (Hannafin et al., 1999) designed as the component of Scaffolding (e.g., conceptual, procedural, metacognitive, and strategic scaffolding),

and Cognitive apprenticeship (Lave & Wenger, 1991) designed as the component of Coaching.

Contextual Study

The results of this study revealed that the current context of teaching of Information for life course are as follows. The main format of teaching format is lectures and students were required to write down the content, the instructor may sometimes use slides presentations. Students are divided into small groups to present their reports in front of the class. The students may be required to use the computer by using various software programs including Microsoft office and the internet. However, it was found that the students did not have experiences instructed in problem-based learning. Besides, the students did not have experiences instructed in the Constructivist learning environment even though there were some tasks requiring problem solving. Also, students were not provided with learning experiences that enhance Critical thinking.

The designing framework of Constructivist web-based learning environments model was synthesized based on above mentioned four stage. It can be illustrated in Figure 2.
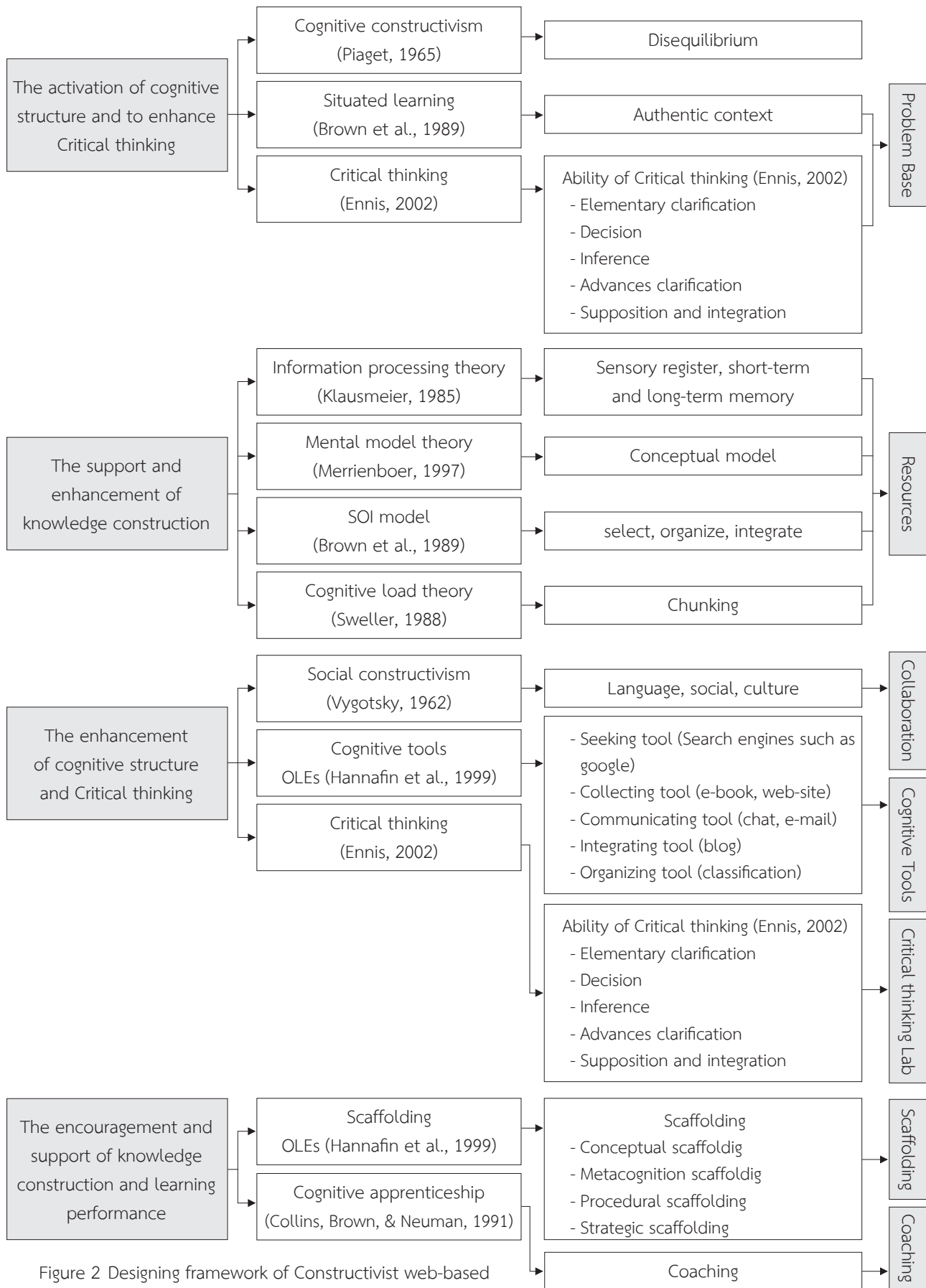
The activation of cognitive structure and to enhance Critical thinking	Cognitive constructivism (Piaget, 1965)	Disequilibrium		Problem Base
	Situated learning (Brown et al., 1989)	Authentic context		
	Critical thinking (Ennis, 2002)	Ability of Critical thinking (Ennis, 2002) - Elementary clarification - Decision - Inference - Advances clarification - Supposition and integration		

The support and enhancement of knowledge construction	Information processing theory (Klausmeier, 1985)	Sensory register, short-term and long-term memory		Resources
	Mental model theory (Merrienboer, 1997)	Conceptual model		
	SOI model (Brown et al., 1989)	select, organize, integrate		
	Cognitive load theory (Sweller, 1988)	Chunking		

The enhancement of cognitive structure and Critical thinking	Social constructivism (Vygotsky, 1962)	Language, social, culture		Collaboration
	Cognitive tools OLEs (Hannafin et al., 1999)	- Seeking tool (Search engines such as google) - Collecting tool (e-book, web-site) - Communicating tool (chat, e-mail) - Integrating tool (blog) - Organizing tool (classification)		Cognitive Tools
	Critical thinking (Ennis, 2002)	Ability of Critical thinking (Ennis, 2002) - Elementary clarification - Decision - Inference - Advances clarification - Supposition and integration		Critical thinking Lab

| The encouragement and support of knowledge construction and learning performance | Scaffolding OLEs (Hannafin et al., 1999) | Scaffolding
- Conceptual scaffoldig
- Metacognition scaffoldig
- Procedural scaffolding
- Strategic scaffolding | | Scaffolding |
| | Cognitive apprenticeship (Collins, Brown, & Neuman, 1991) | Coaching | | Coaching |

Figure 2 Designing framework of Constructivist web-based learning environment model

■■ Discussion

The results of the Framework of the Constructivist web-based learning environment to enhance mechanism and Critical thinking for model undergraduate students consists include 1) Psychological base, 2) Pedagogical base, 3) Contextual base, 4) Technological base, and 5) Media symbol system base, and four stages of The designing framework as followings: 1) the activation of cognitive structure and to enhance Critical thinking, 2) the support and enhancement of knowledge construction, 3) the enhancement of cognitive structure and Critical thinking, 4) the encouragement and support of knowledge construction and learning performance including 6 elements as following: 1) Problem base, 2) Resources, 3) Collaboration, Coaching, 4) Critical thinking lab, 5) Scaffolding, 6) Cognitive tools, and 7) Collaboration. This research result consistant with study of Chaijaroen, Kanjug, & Watkhawlam (2008), Wattanachai, Chaijaroen, & Kanjug (2008), Kanjug (2009), and Samat (2009). The results of this study showed that the elements of the learning environment that can improve students' Critical thinking. In addition, it was found that this designed and developed model was a high quality model, 1) Psychology base, 2) Pedagogical base, 3) Context base such as graduate desirable features, guidelines for teaching, and the essence of the Information for life course, 4) Technological base, and 5) Media symbol system base. In addition, it was found that this designed and developed model was a high quality model, which is evident from the evaluation by the various experts stating that the content was accurate and up to date. Also, the design and media could encourage students to construct knowledge and could enhance their Critical thinking. This may be due to the fact that the design of the learning environment model was based on the theoretical framework and instruction design theories that could translate the principles into practice (e.g., knowledge construction adopting the Constructivist theory). This problem situation can activate students' disequilibrium and to encourage them to solve problem,

leading to the development of cognitive structure. The design of learning environment also adopted the Critical thinking by integrating the Critical thinking lab that allowed students to select knowledge, construct knowledge, knowledge reconstruction, and formation of Critical thinking. These elements encourage students to apply information to new situations. Finally, the findings of this study shed light into the field related to learning environments to enhance students' Critical thinking.

■■ Acknowledgment

■■ References

Anderson, J. R. (1990). *Cognitive psychology and its implication* (2nd ed). New York: Freeman.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32–43.

Bureau of International Relations. (2013, January 17). 21st Century Learning. Retrieved from http://www.bic. moe.go.th/th/index.php?option=com_content&view= article&id=1141:2013-08-19-11-03-39&catid=36: movement-.

Chaijaroen, S. (2004). *The development ofknowledge building by informationtechnology.* Bangkok: Office of research and development in education, Ministry of Education.

――――. 2006. *The Development of knowledge construction of student base on constructivist theory under coorperation of teacher and academic staff.* Khon Kaen: Faculty ofEducation, Khon Kaen University.

――――. (2008). *Educational technology: Principles theories to practices.* KhonKaen: Klungnanawittaya.

――――. (2014). *Instructional design: theory in to practice.* KhonKaen: Penprinting.

Chaijaroen, S., Kanjug, I., & Watkhawlam, W. (2008). *Synthesis of learning innovation model enhancing learning's learning potential using brain-based learning.* KhonKaen: Faculty of Education, KhonKaen University.

Collins, A. J., Brown, S., & Neuman, S. (1991). Cognitive apprenticeship. Retrieved from http://thingsorganic. tripod/Instructional_Design_Model.htm

Ennis, R. H. (2002). Super-streamlined conception of critical thinking. Retrieved from http://tonydude.net/ NaturalScience1000/Topics/1Universe/ criticalthinking.html

Hannafin, M., Susan, L., & Kevin, O. (1999). Open learning environments: Foundations, methods and models. In C. M. Reigeluth (Ed), *Instructional design theories and model: A new paradigm of instructional theory. Volume II* (pp. 39-53). New Jersy: Lawrence Erlbaum Associates.

Jonassen, D. H. (1999). Constructivist learning environments. In C. Reigeluth (Ed.), *Instructional design theories ans models (Vol.II)* (pp. 215-239). New Jersey: Erlbaum.

Jonassen, D. H., & Henning, P. (1999). Mental model: Knowledge in the headand knowledge in the world. *Education technology, 39*(3), 37-42

Kanjug, I. (2009). *Development of learning environments model enhancing expertise mental model* (Doctor of Philosophy Thesis in Educational Technology). KhonKaen University, KhonKaen.

Klausmeier, H. J. (1985). *Educational Phychology* (Sth ed). New York: Harper & Row.

Kozma, R. B. (1991). Learning with media. *Educational Research, 61*(2), 179-211.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

Merrienboer, J. G. (1997). *Training complex cognitive skills: A four-components instructional design models for technical training.* New Jersy: Educational.

Myrmel, M. K. (2003). *Effect of using creative problem solving in eighth grade technology education class at Hopkins North Junior High School* (Masters of Science). University of Wisconsin, Stout.

National Institute of Educational Testing Service (Public Organization). (2008). Basic statistical values of O-Net. Retrieved from http://www. niets.or.th

Office of the National Education Commission. (2002). National education development plan (2002-2006). Bangkok: Amarin Printing and Publishing.

Piaget, J. (1965). *Judgment and reasoning in the child.* London: Routledge & KeganPaul.

Richey, R. C., & Klein, J. (2007). *Design and developmental research.* New Jersey: Lawrence.

Rovai, A. P., & Jordan, H. M. (2004). Blended learning and sense of Community: a comparative analysis with traditional and fully online graduate courses. *International Review of Research in Open and Distance Learning, 5*(2). Retrieved from http://www.irrodl.org/ index.php/irrodl/article/view/192/274

Samat, C. (2009). *The development of constructivist web-based learning environment model to enhance creative thinking for higher education students* (Doctor of Philosophy Thesis in Educational Technology). KhonKaen University, KhonKaen.

Smith, E. E. (1989). Concept and induction. In M. I. Posner (Ed.). *Foundation of cognition science* (pp. 501-526). Massachusetts: MIT Press.

Solomon, G., & Clark, R. (1977). Reexamining the methodology of research on media and technology in education. *Review of education research, 47*, 99-120.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*, 257-285.

The Institute for the Promotion of Teaching Science and Technology. (2009). *Learning Quality of Thai Students: Synthesized the Evaluation of International Students Pisa 2006 and Timss 2007*. Bangkok: Seven Printing Group.

Vygotsky, L. (1962). *Thought and language.* Cambridge: MIT Press.

Wattanachai, S., Chaijaroen, S., & Kanjug, I. (2008). *Design and development of learning innovation enhancing learning potential using brain-based learning.* KhonKaen: Faculty of Education, KhonKaen University.