The constructivist learning environments model enhancing cognitive flexibility for higher education: validation phase

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Abstract
The purposes of this research are to examine the internal validation and the external validation of the development of the constructivist learning environments model enhancing cognitive flexibility for higher education. The target group for the internal validation consists of 5 experts, 1 Instructional Designer, 2 Developers of constructivist web-based learning environment, and 6 lecturers. The target group for the external validation consists of 43 second year students studying in Computer education field in the Faculty of Science and Technology at Nakhon Ratchasima Rajabhat University. The Research Developmental Phase II (Richey and Klein, 2007): Model validation is employed in this study. The Results from the Model Validation are revealed as follows. Firstly, for the internal validation, the model has been examined by 5 experts and it is found that the model design is consistent with underlined theories based on Instruction Design theories (ID Theories). Secondly, for the external validation, it exposes that the students learning with model have high levels of cognitive flexibility and achievements. The average scores of cognitive flexibility test are 63.72 percent over the 60 percent threshold. The average scores of achievements test are 74.9 percent over the 70 percent threshold. The students’ opinions toward the development of the constructivist learning environments model enhancing cognitive flexibility are appropriate in all aspects and the model can enhance students’ cognitive flexibility.

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1. Introduction
Today’s challenge is “to focus on the field of instructional design is a paradigm shift” (Chaijaroen, S. 2005). Several educators advocate the learner-centered approach in education, currently, it is focused on construction of knowledge which is favored in educational settings rather than the transmission of knowledge (Chaijaroen, S., Khanjak, I. et al., 2008). This is consistent with the National Education Act 1999 and Amendment Act (No. 2) 2002 which state that the education will be based on the principle that all learners are capable of learning and developing themselves and the students are considered as the most important. The learning process must focus on skills of thinking process to face the situation and to apply knowledge used to prevent and solve Ill-structured problems in the real world based on learners’ cognitive flexibility. However, the results of the research in phase I: model development which will be published recently (Deejring, K., Chaijaroen, S. in press), lack of verification of
the models in the validation, a feature that indicates the reliability of the applications available to meet the goal of developing models in the study. In phase II: model validation focusing on the evaluation to confirm the quality of the model consists of 1) the Internal validation, which is estimated to improve and develop the model for content validity by experts in the field, the media on the network, and the model design and 2) the external validation of the model whose objective is to study the impact of the design model with the students. In this study, the impact comprises of 1) the opinions of learners learning with the model and 2) the achievement of learners. The results of the study will help to confirm the quality of the model that can be used to enhance flexibility and intelligence of learners more effectively.

2. The Purposes of Research

2.1 To study validation of internal validation of the constructivist learning environments model enhancing cognitive flexibility.

2.2 To study validation of external validation of the constructivist learning environments model enhancing cognitive flexibility.

3. Operational Definition

3.1 The internal validation refers to the examination of the design and development of model in order to confirm the quality of the model by experts in various fields as follows: 1) the content experts, 2) the media experts, and 3) the model design experts.

3.2 The external validation refers to the impact of utilization of the model enhancing cognitive flexibility, according to the framework of the cognitive flexibility theory of Spiro and Jehng (1990), focusing on the knowledge selection, the knowledge deconstruction and the adapted knowledge reconstruction. In addition, the impact of the model is applied to the study of 1) the opinions of learners learning with the model and 2) the achievement of learners.

4. The target group

The target groups used in the internal validation and external validation are as follows:

(1) The target group for the internal validation consists of 5 experts, 1 Instructional Designer, 2 Developers of constructivist web-based learning environment, and 6 lecturers of computer education field in the Faculty of Science and technology at Nakhon Ratchasima Rajabhat University, Thailand.

(2) The target group for external validation consists of 43 second year students studying in computer education field in the Faculty of Science and Technology at Nakhon Ratchasima Rajabhat University, Thailand.

5. The Research instruments

Instruments used in the study and data collection include the followings:

5.1 The instruments for collecting data of internal validation of the model development constructivist learning environment enhancing cognitive flexibility are: (1) The evaluation of quality of the model (2) The designer characteristic survey (3) The developer characteristic survey and (4) The lecturer characteristic survey based on Richey, Klein and Nelson (2007).

5.2 The instruments for collecting data of external validation of the model development constructivist learning environment enhancing cognitive flexibility are: 1) The In-depth interviews used for evaluation of cognitive flexibility using open-ended questions, created by using the framework comprised of the principle of Cognitive Flexibility Theory (Spiro and Jehng, 1990) 2) The opinions of students concerning about learning and teaching with the model (Khan, 1997; Hanafin, 1999; Chaijaroen, S. and others, 2007) 3) The evaluation of the learners’ cognitive flexibility using open-ended questions, created by using the framework comprised of the principle of Cognitive Flexibility Theory (Spiro and Jehng, 1990) and 4) The achievement tests of the students on the 410201 system.
analysis and design subject. For the evaluation of the learners’ cognitive flexibility, the issue is related to education that promotes knowledge construction and cognitive flexibility to solve problems.

6. Data Collection and analysis

The constructivist learning environment model enhancing cognitive flexibility is used with the target group in order to study the validation of the model as following details: (1) Construct knowledge (2) promote learners’ cognitive flexibility.

The data are collected and analyzed by the researcher as following details:

6.1 The internal validation is the examination of the design and development of model in order to confirm the quality of the models by experts in various fields as follows: 1) the content experts, 2) the media experts, and 3) the model design experts. The data are collected and analyzed by using the interpretation analytic descriptive and summarization.

6.2 The external validation of the model is to study the impact of utilization of the model in 2 aspects as follows. The first aspect is students’ cognitive flexibility according to the framework of the cognitive flexibility theory of Spiro and Jehng (1990), focusing on the knowledge selection, the knowledge deconstruction and the adapted knowledge reconstruction. In this aspect, a post-test is conducted. The second aspect is the student’s opinions toward the constructivist learning environment model enhancing cognitive flexibility. The quantitative data of students’ cognitive flexibility are collected and analyzed by using descriptive statistics (X, S.D.). The qualitative data regarding to the student’s opinions are collected and analyzed by using the interpretation analytic descriptive and summarization.

7. The research result

From the study of the constructivist learning environments model enhancing cognitive flexibility, the research results can be summarized as follows:

7.1 The result of examination of the model by the experts, the internal validation of the model, shows that the designing of model is appropriate and congruent with the underlined theories and principles. Learning theories used in this research are Cognitive constructivist based on Piaget (1975), Social constructivist based on Vygotsky (1962), Bruner (1996), Doise and Mugny (1997), media theory and Cognitive Flexibility Theory based on Spiro and Jehng (1990). Those theories used as foundation in the design of the model can enhance knowledge construction and students’ cognitive flexibility.

7.2 The result of the impact of the utilization of the models, the external validation of the model, shows as follows:

7.2.1 The students’ cognitive flexibility:

1) Results from the cognitive flexibility test score: It was found that the cognitive flexibility on the knowledge selection, the knowledge deconstruction and the adapted knowledge reconstruction, helps to improve students for learning system analysis and design at high level. The average scores of cognitive flexibility test are 63.72 percent over the 60 percent threshold.

2) Results from interviews of the students’ cognitive flexibility as follows:

(1) The students understand in 3 steps of the mechanism enhancing cognitive flexibility. These 3 steps are:

(1) The knowledge selection, the students will use prior knowledge by retrieving or recalling prior knowledge from their experiences (2) The knowledge deconstruction, the students will decompose the knowledge in terms of schemas and case studies and (3) The adapted knowledge reconstruction, the students will link and combine the sub knowledge to apply or transfer to new situations. Sometimes they need to change the combination of knowledge again before applying the new combination of knowledge to new situations that the students confront. This mechanism is consistent with the cognitive flexibility theory applying from frame of cognitive flexibility theory of Spiro and Jehng (1990). For example, in the process of the knowledge selection, it is found that the students can retrieve prior knowledge from their experiences. For in-depth interview the students after learning with the model, when the students have to solve the problem on a learning task about the rent car, they select knowledge by
attempting to identify the prior knowledge used to solve a problem with the rent car. To identify such problems, they try to link their prior knowledge with the problem, as shown in the empirical evidence as follows: “We think that the car rent system is similar to the operation of the apartment rental system. Both systems have the same rental process which I have ever done the project about apartment rental system in the database system subject on the last semester.” Another student reveals that “External entities of the car rental system are similar to those of the apartment rental system. This is a key component of our system design. So, we decide to select the apartment rental system for comparing with the problem of car rental”. For the step of the knowledge deconstruction, it is found that the students can decompose their tasks both schema and case, and transfer to new situation appropriately. The empirical evidence is the decomposition diagram of the car rental system which the students write on the paper, as shown in Figure 1.

![Figure 1. Decomposition diagram of the car rent system](image1)

Figure 1. Decomposition diagram of the car rent system

For the process of the adapted knowledge reconstruction, it is found that the students can adapt, transfer and apply knowledge to new situation appropriately. The empirical evidence is the data flow diagram of the car rental system which the students write on the paper, as shown in Figure 2.

![Figure 2. Data flow diagram of the car rental system](image2)

Figure 2. Data flow diagram of the car rental system

They adapted the knowledge about the apartment rental to the car rental by considering that one of the external entities of the car rental is staff. This differs from the apartment rental that is without the staff as an external entity.
The empirical evidence of adapting knowledge is the data flow diagram of the car rental system which the students write on the paper, as shown in Figure 3.

![Data flow diagram of the car rental system with adaptation](image)

**Figure 3. Data flow diagram of the car rental system with adaptation**

The students said that “We think about the rental system if customers, who rent the car, need to do an accident insurance. However, for the apartment rental, customers don’t need to do an accident insurance”. These empirical evidence shows that the students adapt knowledge after reconstruction. From these reasons, we can infer that the students have enhanced the capability of cognitive flexibility. This conforms with the cognitive flexibility theory of Spiro and Jehng (1990).

1. The opinion of students, who learn with the constructivist learning environments model enhancing cognitive flexibility, consists of 3 major issues that are content, media on web and learning environments model, which are appropriate for the students to construct their knowledge and enhance their cognitive flexibility.

2. For the achievement of the students, it is found that the average scores are 74.9 percent over the 70 percent threshold. In addition, it shows that the constructivist learning environments model can enhance cognitive flexibility for higher education students.

7.2.2 Opinions of the students who learned with the constructivist learning environments model enhancing cognitive flexibility, show that the model is appropriate in all aspects and enhances the students to develop their cognitive flexibility as following details: 1) Content is up to date, very interesting and beneficial for them to learn by themselves. The content format design helps them to understand easily. 2) For the context diagram and data flow diagram in the resources, It is revealed that web-base design make them easy to access the information. This helps them to obtain the new information and knowledge easily. This can help them to learn by themselves. 3) The model designs is appropriate; thus it can help the student to enhance their cognitive flexibility in the aspects of knowledge selection, knowledge deconstruction and adapted knowledge reconstruction. This improves students for learning in system analysis and design subject.

The above results of the research and empirical evidences illustrate both the internal and external validation of the constructivist learning environments model enhancing cognitive flexibility.

8. Discussion

The results of the internal and the external validation are revealed as follows. For the internal validation, the model has been examined by 5 experts and it is found that the model design is consistent with underlined theories based on Instruction Design theories (ID Theories). For the external validation, it is found that students learning with model have high level score in students’ cognitive flexibility. The average scores are 63.72 percent over the 60 percent threshold and the standard deviation is 2.21; furthermore the student’s opinions toward the constructivist learning environment enhancing cognitive flexibility are appropriate in all aspects and the model can enhance
learner’s cognitive flexibility. These findings are consistent with the study of Chaijaroen, Sumalee and others (2008); Chaijaroen, Sumalee (2008); Khanjug, Issara and Chaijaroen, Sumalee (2009); Samart, Jarunee and Chaijaroen, Sumalee (2009); Wattanachai, Suchart and Chaijaroen, Sumalee (2010); Gumlunglert, Thitima and Chaijaroen, Sumalee (2011); studying about the validations of the model. In addition, It is also consistent with Monica W. Tracey (2009) studying on the design and development for the model of multiple intelligences. Forsyth (1997) studied on the construction and validation of an instructional systems design model for community-based train-the-trainer instruction by using the Developmental research Phase 3 and found the efficiency of the ISD models and programming TtT.

The above mentioned findings of the internal validation and the external validation of the model may cause from the instructional design using ID Theory. Theories used here are Cognitive Flexibility Theory based on Spiro and Jehng (1990), learning theories: Cognitive constructivist based on Piaget(1975) and Social constructivist based on Vygotsky (1962), Bruner(1996), Doise and Mugny (1997), cognitive theories, media theory and media symbol system. Those can enhance the student’s cognitive flexibility. Based on the theories used as foundation in the design of the model, this leads to enhancing the student’s cognitive flexibility. In addition, the specialized designer may result in the internal validation of the model. Since she specialize in lecturer in computer education for more than 20 years and also has the educational background; moreover she is studying in Doctor of Philosophy Program in Educational Technology focusing on Instruction design especially ID Theory. Consequently, this may help in designing the components of the model congruent with those underlined principles and theories. This may result in the internal validation of the model. It can be supported by the empirical evidences from the above mentioned experts’ examination and evaluation of the model. Moreover, this model has combination between the theories and practices; therefore the design activities as problem situations, authentic tasks in the real context increase the efficiency of the model. By using information and communication technology in the cognitive flexibility enhancing room can promote cognitive flexibility processes. This may affect the impact of the utilization of the model to enhance the students’ cognitive flexibility both in test scores and in performances of knowledge selection, knowledge deconstruction and adapted knowledge reconstruction; thus it improve students for learning system analysis and design subject. It can be supported by the empirical evidence from the interviews as following details.

“In enhancing cognitive flexibility room, there are principles to promote cognitive flexibility that help students to understand holistic of context diagram and data flow diagram .” The students may choose other elements called related cases or expert clinic. For the expert clinic, the experts in system analysis and design provide suggestion to students. Consequently, the students will get multiple perspectives and prevent misconception. The empirical evidence as follows: the students said that “The related cases help to increase experience to solve problem”. The element called scaffolding based on the zone of proximal development of Vygotsky (1962) help the students who are under the zone of proximal development. The empirical evidence as follows: the students said that “This element has four scaffolding as follows: 1) conceptual scaffolding to hint learners about concept to analyze process in system analysis and design. 2) metacognition scaffolding to help learners to solve problems by themselves. 3) procedural scaffolding to guide line in each elements. 4) strategic scaffolding to guide line and hint students to solve problems”. The other element called cognitive tools based on cognitive tools of Iiyoshi and Hannafin (1996) help students to promote learning”.

These elements in the constructivist learning environments model enhancing cognitive flexibility are derived from synthesising theoretical framework, designing framework. Each of elements of the model is defined to enhance cognitive flexibility consistent with Monica W. Tracey (2009).

The various findings of this study and empirical evidences can suggest that the model can be illustrated both the Internal and External validation. This may result in the constructivist learning environments model enhancing cognitive flexibility that illustrate by the learners’ cognitive flexibility test scores, achievement test scores, and interview results.

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References


