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The Design and Development of the Cognitive Innovation to Enhance Problem Solving

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Abstract: The purpose of this research was to design and develop a cognitive innovation to enhance problem solving. The target group were the 3 experts who reviewed document and designing framework and the 3 experts to evaluate the cognitive innovation. Research designs was the Developmental Research Type 1 which comprising of 3 processes: 1) Design Process and 2) Development Process, which comprising of synthesis of theoretical and designing framework and develop the cognitive innovation and 3) Evaluation Process which evaluated the efficiency of the cognitive innovation. The results were revealed that: the synthesis of the designing framework based on theoretical framework which then put into practicing comprised of 8 components as the following: 1) Problem base, 2) Learning resource, 3) Related case, 4) Cognitive tool, 5) Collaboration, 6) Center for enhancing problem solving, 7) Coaching and 8) Scaffolding; and reviewed the effectiveness by experts in the evaluation process as follows: 1) product assessment, 2) contextual utilization assessment, 3) learner's opinions assessment; the cognitive innovation to enhance problem solving is appropriate on 3 aspects: content, media and designing, 4) assessment of learners' cognitive ability; The problem solving abilities were found 6 procedures of student's problem solution as (1) identified problem gap, (2) identified and explained exact problems, (3) created possible solutions, (4) evaluate the possibility of solution use, (5) applied the solution, and (6) adjusted such solutions, and 6) assessment of learning achievement ($\overline{X}$=18.75, S.D. = 1.78) that every learner passes the 70%criterion of the specific scores.

Keywords: Cognitive innovation, pedagogy, problem solving, instructional design

1. Introduction

The continuous fast developing of technology in recent many decades makes people live in the world without territory. Able to communicate and access to data anytime at the same time together, meanwhile; confront of various kinds of problem such as politic, economic, and social issues which all effect to people life. These troubles cause from natural crisis which human cannot stop them, however; the most serious problems cause from human. Presently, this kind of knowledge and complex society influence the big changes in Thailand and other parts of the world. This is risk to opportunity growing and country development. Hence, the education is the key to improve human skills and potentials to live in this high competitive society. Able to prepare and adapt into the circumstance. Furthermore, able to face and solve any problems regards the internal and external changing of a country, in according to learning skills in the century 21st, ASEAN Economic Community, and The Eleventh National Economic and Social Development Plan (2012-2016) (Office of the National Economic and Social Development Board, 2011) especially the strategy 2- the development of human for the sustainability of lifelong learning society which emphasizes on lifelong learning enhancement, fostering the social norm that each people realize their role to learn, reading lover since primary age and promoting to integrated learn among different age of people. Moreover, enhance organizations, society, people, and all kinds of media to be as a creative learning resources via simple language of communicationas well as support people to have learning alternatives which most appropriate to them. Also, create knowledge society with high quality in order to foster people to have lifelong learning and to be able to create an innovation due to the strong background of being open-mind, sincere, and disciplinary. They are enhanced through integrated knowledge in order to work in many job functions depends on work hiring trend and AEC.

So, the learning management which most appropriates to the current era of knowledge society, the learning is not only about the transmitting of knowledge that not enough to be adaptively used to solve complex problems nowadays, but learning is about the knowledge construction by students themselves which they can be solve such kind of problem. As mentioned, the learning paradigm should be emphasized on the changing of "teaching" to "learning" which the learner is focused as a center. The design enhances them to be developed naturally and fully efficiently. The information and technology is used to foster them to construct knowledge in the whole their life (Chaijaroen et al, 2008), in accordance with the National Education Act of B.E.1999 and Second Amendments of B.E. 2003 which states that the learning management must emphasize the learner to be able to learn and develop themselves, also the learner is the most important people in the learning processes. In learning design, the skills practicing, thinking process, confronting and managing of problems, and knowledge adaptation should be highlighted in order them to have the ability to solve a problem, love to learn, and use educational technology to serve for knowledge throughout their life. The solving problem skill is one kind of a complex thinking process. It consists of various cognitive components including knowledge construction structure for example, knowledge network, thinking network, including cognitive process with purposive thinking, knowledge construction, knowledge assessment, error assessment process (Jonassen and Tessmer, 1996). These components are created from several kinds of science as learning theory, pedagogy, technology, media attribute, and related context. Then they are synthesized as theoretical framework and used to design learning environment in the purpose of enhancing such learner's thinking processes, especially the ability to solve a problem and have lifelong learning according to such National Education Act pf B.E.1999.

The integration is here explained as it is the integration among neuroscience and related pedagogies as constructivism which mainly on learner's knowledge construction, complex problem solving, and authentic situation. Also, media attribute, media symbol system, and the advantages of technology can as well help the learner to have more efficiency on learning. The contructivist theory hereby explains how the learner have knowledge construction by themselves and response to paradigm changing through cognitive processes. The prior knowledge or experience is connected to the new knowledge through schema, this believes that the learner constructs new knowledge by enlarging or adapting their schema. The teacher hence cannot do anything with their schema but have important role to design and develop learning environment for them to be able to construct knowledge and be in authentic problem situation. The learner is actively constructed the knowledge throughout their own cognitive processes. Therefore, this research is the integration of theory and principles as well as the pedagogy in purpose to solve the ill-structured problem in authentic situation and combination with media attribution and symbol system and technology (Chaijaroen, 2014). The previous research results found that the learning with constructivist learning environment could help the learner to have deeper understanding more than passively received data. Likewise, social constructivist or learning with other people in social interaction had positive effect to leaning which consistent with the studies. The design and development of learning environment which mainly fosters on the intensive of cognitive process and problem solving skills was found that the problem solving under several condition processes could help the learner to construct their conceptual thinking which hence used in and promoted process and certainly knowledge construction. Furthermore, the problem solving by using computer was found that the learner could significantly have the better work than working alone, also the good attitudes towards problem solving by using a computer to problem transferring skills (Uribe et al, 2003)

Regards the mentioned rational and background, the researchers realized the importance of the development of cognitive innovation to enhance problem solving based on several backgrounds, and then synthesized thetheoretical framework based on theories and related researches in area of knowledge construction and problem solving. After that, designed and developed the cognitive innovation to enhance problem solving by emphasizing on cognitive process and then integrated with neuroscience in order to affirm the evidence what happen in their cognitive processes; as well as to deepen the research findings and expand the research connection for both national and international. The results effected to the human potentials which very important to the cooperation and competition among countries according to the policy of the national research of enhancing cognitive innovation to be able to have new and more foundation of economic innovation.

2. Research Purpose

To design and develop the cognitive innovation to enhance problem solving.

3. Research Methodology

The Developmental ResearchType1 was employed (adapted from Richey and Klein, 2007) which consisted of 3 processes asfollows1) design process, 2) development process, and3) evaluation process.

4. Target Group

The study target groups were divided into 3 groups regards to these 3 processes as follows: 1) Design process: 3 experts to assess the conceptual framework in innovation design and the designing. 2) Development process: 3 experts to assess the efficiency of the cognitive innovation for the aspects of content, media, and design. 3) Evaluation process: 24 students of Pratomsuksa 6 of Hinladwangtoe School who studied in Science subject in semester 1/ 2015.

5. Data Collection and Analyze

The data was collected and analyzed in each process as follows:

5.1 Design Process

- Literature review: studied and analyzed theories, principles, and related researches concerning the design of cognitive innovation to enhance problem solving in terms of 1) constructivist 2) cognitivism including media attributes, media symbol system, multimedia as a study background, and then recorded in a document recording form. The data was analyzed by the methods of interpretation and analytical description.
- Theoretical framework: reviewed, studied, analyzed the mentioned theories and researches in literature review process, and then recorded in the theoretical framework recording form. The data was analyzed by the methods of interpretation and analytical description. The framework consisted of 5 foundations as 1) psychological learning base, 2) pedagogical base, 3) contextual base, and 4) technological base.
- Contextual study: studied the school polices, instructional management in Science Learning Substance which focused on problem solving. The data was collected by surveying on context of instruction and learning in the science classroom and interview both teachers and students by focusing on problem solving context. The data was analyzed by the methods of interpretation and analytical description.
- Designing framework: synthesized the designing framework based on theoretical framework and contextual study, and recorded in the designing framework synthesized recording form. The data was analyzed by the methods of interpreting and analytical description.
- Synthesized the cognitive innovation components to enhance problem solving based on designing framework by emphasizing on knowledge construction and problem solving and transformed theory into practice as the 9 components.
- Proposed the designing framework and the innovation components to the researchers to criticize and assess in order to use its results to improve the innovation.
- Proposed the designing framework and the innovation components to the experts to verify the consistency between designing framework and the innovation components and criticized and assessed to improve the innovation.

5.2 Development Process

- Developed the cognitive innovation to enhance problem solving based on the designing framework and the design of innovative components.
- Proposed the innovation to the researchers to criticize and assess the innovation quality. The data was analyzed by interpretation and in descriptive analysis to be used to improve the innovative quality.
- Proposed the cognitive innovation to the experts to assess 1) content, 2) media, 3) design and recorded on the innovation quality assessment form for experts. The data was analyzed by data interpretation to be used to improve the innovation quality.
- Try out the innovation to study: the context of utilization, the most efficient students who learned with the innovation, the instructional design with cognitive innovation, and students' opinion towards the innovation use thru the innovation-use surveying form, innovation-opinion surveying form, and interviewing form of context of use. The data was analyzed by interpreting and in descriptive analysis.

5.3 Evaluation Process

The cognitive innovation quality was verified by the experts in phase 1 and try out with the students who apart of target group in the purpose of studying the contextual utilization in phase 2, however; was used with the target group in authentic context then. The teacher in their classroom was trained in instructional design and cognitive innovation workshop. The researcher hence studied students' cognitive process as terms of 1) their problem solving while learning with the cognitive innovation via protocol analysis by interviewing and interpretation based on Problem Solving principles (Jonessen, 1997), 2) studied their problem solving with learning with the cognitive innovation through assessment of Executive function in problem solving process by Tower of London, and analyzed data by using descriptive statistics as ratio, mean, S,D., and percentage by comparing the proportion of the number of time spending while processed problem solving, 3) their learning achievement was analyzed by using descriptive analysis as mean, S.D., and percentage, and 4) their opinion towards the cognitive innovation analyzed by interpretation and descriptive analysis.

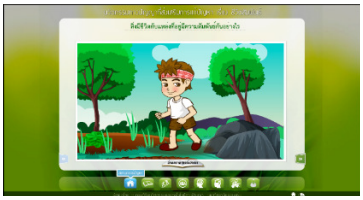
6. Research Results

This research was purposive to design and develop the cognitive innovation to enhance problem solving which the results were presented in 2 processes as Design and development process and Evaluation process

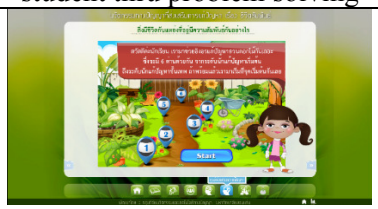
6.1 Design and Development Process

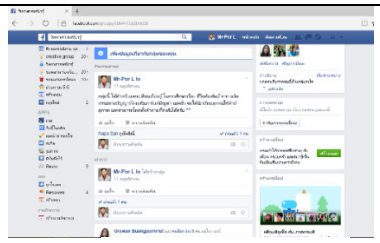
In this process, the results of the design and development based on the designing framework consisted of 1) activated cognitive structure and problem solving, 2) fostered to adjust cognitive structure and problem solving, 3) fostered to enlarge cognitive structure and problem solving, and 4) supported to equilibrium cognitive structure and enhance problem solving. The innovation was verified by the expert reviewer in term of the theoretical and designing framework validation as well as 9 components as 1) Problem base, 2) Learning resource, 3) Related case, 4) Cognitive tool, 5) Collaboration, 6) Center for enhancing problem solving, 7) Coaching, and 8) Scaffolding. Each was explained for the designing of the cognitive innovation to enhance problem solving below, detailed in Table 1.

Table 1: The design of the cognitive innovation to enhance problem solving

Components	Description of components	Design
Problem base	The important component of the cognitive innovation which is like a door to evoke the learners' schema. The design based on Cognitive constructivist of Jean Piaget which emphasize on the active learners who construct knowledge. This believes that when the learners have cognitive conflict or in disequilibrium stage, they try to adjust their cognitive structuring into equilibrium by the way of assimilation or accommodation. Regards the mentioned principles, they were transformed theory into practice as problem base where the enabling context was the situation in authentic context related to their daily life.	 Screen of the cognitive innovation to enhance problem solving
	This helped the learners to be able to connect with their own prior experiences. Also, the components design as ill-structure problem based on Jonassen (1997) comprised step 1 the learner specified space of problem, step 2 clarify and explain the real problems, step 3 create possible solutions, step 4 assess the possibility of selected solution, step 5 use the solution to solve the problem, step 6 refine the solution. There were 5 situations in conceptual content of Life relationship as 1) Relations of life relationship, 2) Relation of life and habitat, 3) What is life cycle?, 4) What is food chain ?, and 5) How does it live? which all led the students learned and solved the problems.	 Problem base and learning tasks about Relation of life and habitat
Learning resource	Learning resource was the collections of learning resources where the learners could use in solving a problem they confronted in Problem base while they had the process of knowledge construction by themselves, along with the various kinds of information in many resources presented in well designed as concept maps which presented the whole content thru graphic and animation in order to demonstrate object shapes, highlighted important information with colors, sizes, underline, and several conceptual maps to demonstrated the relations of the information. Importantly, the learning resources must be enough for them and be designed to be alternatively selected for them to solve the problems and construct knowledge. Moreover, the Extraneous cognitive load of Sweller (1988) was used in designing to reduce the extraneous cognitive load since they were too much information over the information process working function. So, the designing worked on categorizing in Hierarchical, in conceptual models, in sufficient information, and in appropriateness of media attribute and media symbol system. As that so, they were designed the learning resources as follows 1) conceptual maps presented the whole relations of content, 2) graphic, animation presented object shape moving, 3) information highlighted as colors, sizes, underlines, 4) conceptual models in Figures presented each connected concepts, and 5) information categorizing in Hierarchical	 Learning resources  Learning resourcesshowed Relation of life and habitatwhere the learner could click anywhere

Components	Description of components	Design
Related case	Related case based on CLEs (Constructivist learning environments) - the design of constructivist learning environment of Jonassen (1999). The important principle was to design to relate the experiences that similar to the problem which the students could refer and connect to their prior experience. The related case supported the students in 2 kinds as 1) helped them to meaningfully processing the information because they most understood the lesson which they got involve and put their effort in their learning process, and 2) helped to present the complex knowledge with various thinking concepts or problem interpreting of their own. The related case was design based on the theory of cognitive flexibility which designed and presented in various context in many complex levels embedded in information. So, in this case, the designing was designed in cases study related their daily life such as Fish Housing- the students could study this information and use to solve the problems about Life and its habitat relations. This would help them to think and solve other problems in the similar situation. This presented in terms of case samples, solution methods, and reasons.	 Related case presented Fish Housing the related case to Life and its habitat relations
Scaffolding	was the component to adjust the cognitive equilibrium to enhance problem solving based on Lev Vygotsky which believes that "the social interaction is important to develop the cognition", also "Zone of proximal development" presented the concept that the students who were in lower of the zone would have to have the Scaffolding which focused to help them in push the effort thru learning more than do a task. The scaffolding importantly presented and designed conceptual framework to help them to learn and act in learning process more than focused in their competency. Based on Hanafin (1999), the scaffolding consisted of (1 Conceptual scaffolding (2Metacognitive scaffolding (3 Procedural scaffolding (4Strategic scaffolding. The Conceptual scaffolding helped the students to think conceptually and guided them to access the learning resources or other learning resources. The research team design to show the relationship of each topics by summarizing the main ideas and designed in Figure which they could fine the relations of each content. The Metacognitive scaffolding was the scaffolding to support their learning process and guide thinking process in order to solve the problems via suggested strategies as a Guideline based on Flavell (1979), so they could monitor and assess their own thinking of problem solving. The Procedural scaffolding was the scaffolding to suggest to use resources and tools of the system and its working. The Strategic scaffolding was the scaffolding of an alternative to support analytical thinking, strategic planning, and problem solving strategy while learning. This importantly presented in clarifying of required information, assessing of provided resources, and connecting the relations of both prior and new experiences in forms of Figure of relationship which the students analyzed and then solved the problems.	 Scaffolding  Conceptual scaffolding helped the students to create conceptual thinking  Metacognitive scaffolding helped to enhance thinking process  Procedural scaffolding

Components	Description of components	Design
		suggested the instruction of the cognitive innovation  Strategic scaffolding helped the student thru problem solving
Center for enhancing problem solving	Center for enhancing problem solvingthe research team designed the innovation to create the problem situation in authentic context, to practice their problem solving skills, and to collaborate them on solving problems, so this made them deeply understanding. The problem solving process of Jonassen (1997) was applied as follows: process 1 identify the space of problem, process 2 examine the exact problems, process 3 create the possible solution, process 4 assess the selected possible solution, process 5, create the guideline of use such solution, process 6 adjust such solution. The designed situation was designed to be ill-structure such as “Miss Ink-orn gardens on her house, they are many big and small trees and a fish pond. However, there are many problems of planting and fisher for example; “Miss Manee feeds tilapia fish in naturally. She plants water tree in the pond and can have the big tilapia fish. But then, the frog spawn spreads out rapidly and water plant died. She solves the problem by get the frog spawn out to make the pond clean but it is no food for the fish instead. So, the fish size becomes small.” The learning tasks was provided to the students to practice problem solving in 6 tasks as follow: task 1) the learners analyzed the problem space towards the questions of problem, solutions, and conditions after solved the problem; they also verified and reviewed such problems, the problem concise, the validity and sufficiency of the resources, and how to provide information to solve such problem, task 2) the students identified and explained the real problems, the causes of problems by thinking about the possible problems that could happen and also the possible causes, they had to analyze to explain the problem and its causes, task 3) they created the possible solutions which designed for the students to find their problem solving process, their analysis of problem causing, their identification of problems and solutions, their thinking towards the possible solutions as in flowchart, task 4) the assessment of the use of possible solution, designed for the students to assess their solution (from task3) which could have be able to solve authentically by discussing to have the agree and disagree with reasoning, hypothesizing, assessing, and creating the most possible solution which could be reflect to find the decision towards the solution selecting, task 5) applied the selected solution which the students applied such solutions and monitored by using these questions: Does this solution make the student to want to use with the problem?, Is this possible acceptable in groups?, Does this solution get efficiently success in being used to	 Center for enhancing problem solving

Components	Description of components	Design
	solve the problem?, the students had to consider the solutions, adjusted it and concluded in real solution, and transfer it into other context, task 6) adjusting the solutions which designed to the students to adjust the solutions by giving feedback of solution, the success of solutions towards such problems	
Cognitive tool	Cognitive tool was a tool to help the students to construct their knowledge, the design based on (Hannafin, 1999) which hold the cognitive tools designing based on Constructivist along the principles of Information Processing theory and Cognitivism theory. The students had to be supported to do the tasks. The cognitive tool was designed under the advantages of computer competency which able to help them to process information. The tool consisted of 1) Seeking tool: supported them to search related information, addressed information site by Search engines as Google, 2) Collecting tool: help them to collect related information by using Google drive, 3) Organizing tool: help them to organize related information and to connect related concepts via information organization as external link, and 4) Integrating tool: help them to integrate related information with their thinking concepts.	 Cognitive tool
Collaboration	Collaboration was the component designed to elaborate cognitive structure by student's collaboration. They collaborated to solve problems by discussed and exchanged their similar objective of solving, so designed to have Social network as Facebook where they could express opinions and reciprocal their thoughts. This based on OLEs- Communication tool of Hannafin (1999) and which was the tool to communicate among students, teachers, and experts at the same point of time, for example; Facebook messenger which they could share opinion and perspectives among classmates, teacher, and experts during the entire time they spent in the Collaboration.	 Chat onFacebook Messenger for brainstorming
Coaching	Coaching was the component mainly to help the students to be able to do complex tasks with two models as observable process model and expert practicing model including cognitive process which invisible. Hence, the good practice should let the student learn with demonstration or expert model with explanation, especially in Science subject which required student's practice. Coaching helped them to learn the correct procedures, its own reasons with the explanations. Also, learned with cases which helped them to meaningfully learn. Importantly, coaching helped them by monitoring and relating them not to have the misunderstanding in the subject content and instead have the correct understanding immediately. Moreover, coaching could help them to develop to be an expert. The Cognitive Apprenticeship of Collinset al (1989) was used as a principle to shift them from being novice to expert. Coaching also gave hints when the students made a request. Bransford (1989) stated the effective coaching is the monitor student's task in order to prevent the misunderstanding by giving students time to survey and solve the problem in classroom, reflect	 Coaching

Components	Description of components	Design
	and compare their tasks. so this component was designed in accordance with this principle by setting the teacher to analyze student's feedback, guide them in learning process, provoke their cognitive processing including problem solving and active learning thru effecting on their performance both in learning and doing tasks. The researchers design this coaching as in the classroom and online where they could raise a question to the expert all the time.	

6.2 Evaluation Process

In evaluation process based on Chajaroen (2014), it consisted of 1) evaluation of innovation, 2) evaluation of context of use, 3) evaluation of students' opinions, 4) evaluation of cognition, and 5) evaluation of student's learning achievement as follow:

6.2.1 Evaluation of The Innovation

Evaluation of the innovation: Evaluated the cognitive innovation by the expert thru content which found the validity of background theory in designing. The designing framework consisted of 1) Problem base, 2) Learning resource, 3) Related case, 4) Cognitive tool, 5) Collaboration, 6) Center for enhancing problem solving, 7) Coaching and 8) Scaffolding which all components consistent with the mentioned background theory obviously.

6.2.2 Evaluation of Context Of Use

Evaluation of context of use: the appropriate group size was 3 students to collaborative solve a problem, they collaborated to study and do tasks such as solve a problem, search information, allocate group member task in order to complete the tasks in time and quickly. 2 group members were too small to complete tasks in time, and more 3 group members could lead the member not to see the screen clearly and not to have the attention in the tasks.

6.2.3 Evaluation of Students' Opinions

Evaluation of students' opinions: Studied their opinions towards the innovation throughout the survey from and the interviewing which comprised 1) content: found that the content of Life relationship was appropriated with the student's level. It was not too difficult and too easy, and was up to date, complete, and clear for them to study and solve the problems, 2) media: found the designing of Navigator which helped them to easily search information and suited to their need, the Icon showed the meanings of information resources and connected to links to access to other information, Post helped them to learn via Facebook, the Architecture in the innovation was suitable, highlighted, interesting via Figures, alphabets sizes and colors. The students thought that the graphic in the innovation was good and appropriated to the content, the colors and sizes was very interesting to them, and 3) designing: found that all components in the innovation were appropriated.

6.2.4 Evaluation of Student's Cognition

Evaluation of student's cognition: evaluated their cognition via 2 kinds as 1) interviewing and protocol analysis which found 6 procedures of student's problem solution as 1) identified problem gap, 2) identified and explained exact problems, 3) created possible solutions, 4) evaluate the possibility of solution use, 5) applied the solution, and 6) adjusted such solutions; and 2) evaluated via Executive function by Tower of London which was the comparing of counting time and duration used in solve a problem before and after classroom. The results was found that they had a better on problem solving after learned with the cognitive innovation where they moved the dished in 6 times (least time) and spent less time than earlier.

6.2.5 Evaluation of Learning Achievement

Evaluation of learning achievement: The learning achievement of the 24 target group was found that the posttest was $\bar{x}$ = 18.75, S.D. =1.78 more than pretest $\bar{x}$ =5.25, S.D. =2.23 which 85% of the students passed 70% of the subject standard.

7. Conclusion and Discussion

Regards the design and development of the cognitive innovation to enhance problem solving, it was found that the innovation consisted of: 1) Problem base, 2) Learning resource, 3) Related case, 4) Cognitive tool, 5) Collaboration, 6) Center for enhancing problem solving, 7) Coaching and 8) Scaffolding. It consisted of Kwangmuang et al (2012), Chaijaroen et al (2012), and Yampinij and Chaijaroen (2012) studies that used Constructivist theory to be basis of the design and development of the innovation to construct knowledge. But this research had the originality in student's knowledge construction with problem solving by focusing on cognitive processes. Its finding hereby helped the students to solve the complex problems eventually.

The evaluation of the innovation comprised 1) evaluation of designing framework by expert reviewer which found the theoretical validity in background, 2) evaluation of the innovation which found that appropriateness of all 3 aspects as 1) content, 2) media, and 3) designing, 3) evaluation of context of use which found that 3 members in a group was appropriate, 4) evaluation of their opinions which found that the appropriateness of content, media, and designing, and 5) evaluation of cognitive process which found that they could solve the problem better after learned with the innovation based the evaluation of Executive functionby usingTower of London where they moved the dished in 6 times (least time) and spent less time than earlier, and 6) evaluation of learning achievement which found that the posttest score was higher than pretest and passed 70% of the standard.

The above results might be influenced from the instructional design based on ID theory which designed to bring the theory into practice and exactly into the innovation components based on Jonessen (1997) of 6 processes problem solving. It fostered the students to authentically practice to analyze, identify, create possible solution, select the best possible solution, and use in real situations. In Problem base, the media attribute of computer was used to help the students to be able to collaboratively work with their classmates to solve the problems. Also they could interact and record their solving processes in the innovation suddenly it came up while learning throughout authentic situations. Moreover, the designing process, development process, and evaluation process were all focused on the outcomes to be used to improve the innovation quality efficiently. The feedback was recursive and used to improve its quality. This effected to the development of human efficiency which was important to develop the quality of human resource and response to the National Research framework of cognition and innovation development in order to be ready for the competitive and cooperation among AEC and world countries,

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References

Bransford, J. D. & Vye, N.J. (1989). A perspective on cognitive research and its implications for instruction. In L. Resnick& L. E. Klopfer (Eds*.), Toward the thinking curriculum: Current cognitive research* (pp. 173-205). Alexandria, VA: ASCD.

Chaijaroen, S. (2012). *Constructivism theory*. KhonKaen: Faculty of Education KhonKaen University.

Chaijaroen, S. (2014). *Instructional design: Principle and theories to Practice*. KhonKaen: annaoffset.

Chaijaroen, Sumalee; Kanjag, Issara and Watkhawlam, Worakit. (2008*). Synthesis of Learning Innovation Model Enhancing Learning's Learning Potential Using Brain-Based Learning*. Faculty of Education, KhonKaen University.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum Associates.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist*, 34, 906 - 911.
Gijbels, D., van de Watering, G., Dochy, F. et al. InstrSci (2006). New Learning Environments and Constructivism: The Students' Perspective. *Instructional Science, 34*(3), 213–226.
Hannafin, R. D. (1999). Introduction to special issue on instructional technology and teacher education. *Educational Technology Research and Development, 47*(4), 27-28.
Jonassen, D. H. (1997). Instructional design model for weIl-structured and ill-structured problem-solving learning outcomes. Educational Technology: *Research and Development, 45*(1), 65-94.
Jonassen, D. H., & Tessmer, M. (1996). An outcomes-based taxonomy for the design, evaluation, and research on instructional systems. *Training Research Journal.*
Kwangmuang, P., Chaijaroen, S., Samat, C., & Kanjug, I.. (2012) Framework for Development of Cognitive Innovation to Enhance Knowledge Construction and Memory Process. *Procedia - Social and Behavioral Sciences, 46*, 3409-3414.
Office of the National Economic and Social Development Board. (2011). *Poverty and inequality situation in Thailand 2010*. Bangkok: The National Economic and Social Development Board.
Richey, R. C. & Klein, J. (2007). *Design and developmental research*. New Jersey: Lawrence.
Chaijaroen, S., Kanjug, I., & Samat, C. (2012). Development and efficiency improvement of the learning innovations enhancing learners' thinking potential. *Procedia - Social and Behavioral Sciences, 46*, 3460-3464.
Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12,* 257-285.
Uribe, D., Martinez, W., & Ceron, J. 2003. Cry genes in negative strains of Bacillus thuringiensis obtained from different ecosystems from Colombia. *Journal of Invertebrate Pathology, 82*, 119-127.
Yampinij, S. & Chaijaroen, S. (2012). The validation of knowledge construction model based on constructivist approach to support ILL-structured problems solving process for industrial education and technology students. *Procedia - Social and Behavioral Sciences, 46*, 5153 – 5157.