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Development of Web-Based Learning Environment to Promote Problem Solving on Problem Solving in Computational Science for Secondary School

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DEVELOPMENT OF WEB-BASED LEARNING ENVIRONMENT TO PROMOTE PROBLEM SOLVING ON PROBLEM SOLVING IN COMPUTATIONAL SCIENCE FOR SECONDARY SCHOOL

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Abstract. The objectives of this research are 1) to Development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school, 2) to study problem-solving thinking of Development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school, 34 students in semester 2, academic year 2021. This research used a Pre Experimental Research model. The design and development were based on the Richey and Klein model (2007). A tool used to collect data as problem solving measure, Data analysis is students' problem solving. The basic statistical values were used to analyze the mean deviation (M.D.) and standard deviation (S.D.) The research showed that; 1. There are 6 important elements in the results of the design and development of the learning environment on the network which supports solving problem namely, 1) problem situations, 2) learning resources, 3) collaborations, 4) problem solving promoting room, 5) scaffolding, and 6) coaching. 2. learned through learning environment development on Development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school The mean score was 27.28, representing 93.77%, which was higher than the specified threshold of 60% of the full score. The Understanding the problem ($\bar{x}$ = 11, S.D. = 0.51) , the Devising a plan had ($\bar{x}$ = 5.59, S.D. = 0.50), the Carrying out the plan ($\bar{x}$ = 6, S.D. = 0), and the Looking back ($\bar{x}$ = 5.51, S.D. = 0.36)

Keywords: Learning environment, Problem solving, Web-based learning.

1 Introduction

21st Century Education Challenges. Preparing students for life in the 21st century is an important aspect of the 21st century social transformation trend affecting the way

people live in society. Teachers need to be alert and prepared to manage learning for students with the skills for living in a 21st century world. The most important skill is Learning Skill, which has resulted in a change in learning management so that children in the 21st century have the knowledge, abilities, and essential skills (Wichan Panitch (2012: 16-21)).

It corresponds to problem solving, a thinking skill that is important to learners' development (Pornsawan Vongtatham, 2015). The difference in the past was caused by many changes in various fields. Especially technology that has changed by leaps and bounds. As a result, education management must focus on students as the center of learning to know the process of creating knowledge by yourself and from problem solving. It's not just thinking and using your brain, or it's a skill aimed at improving your intelligence solely. It is also a skill that can develop attitudes, thinking methods, values, knowledge, and understanding of social situations which the education system must focus on development and training youths to have more opportunities to practice problem-solving skills (Suwit Munkham. 2008).

From the problematic situation, it is necessary to adjust the learning management model to promote consistent problem-solving thinking for learners to build their own knowledge, capture the most important knowledge points so that learners can connect important knowledge with other relevant knowledge. This is the creation of knowledge for learners to learn anywhere and at any time. This learning management method is consistent with the constraint theory. Knowledge is connected with the surrounding things from past experience to form a cognitive structure. The learning environment approach helps learners expand their intellectual structure. The purpose of this study is to eliminate conflict through students' thinking. When students are troubled by problems, it is believed that learners will use these strategies to solve problems. In the learning process, this supports the thinking process of learners' knowledge creation. The management of learning environment is called learning environment based on Constructivism. (Sumalee Chaicharoen, 2547)

This approach is therefore highly consistent with the nature of technology (computational science) on problem solving, grade 1 emphasizes computational thinking and analytical thinking , think problem-solving in a systematic and step-by-step manner, analyze, synthesize and apply information to solve real-life problems and work together creatively for the reasons mentioned above. Therefore, the researcher is interested in doing research on the Development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school in order to use the research results to continue support effective learning management. As a game based learning environment, it is an educational strategy that helps promote thinking skills and learning processes for players. Currently playing games, it is an entertainment that is hidden with substance and promoting learning is very useful. The researcher sincerely hopes that this research will enhance students' problem-solving skills.

2 Research objectives

2.1 To development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school.

2.2 To study the students' problem-solving thinking through a web-based learning environments to promote problem solving on problem solving in computational science for secondary school.

3 Research scope

This research is development research (Richey and Klein, 2007), which focuses on the design and development process. It aims to design and develop a learning environment on the network which in this design and development process consists of document research, a study of the context of teaching and learning management, synthesis of design conceptual frameworks, designing and creating a learning environment model and improving the quality. Conducting research details are as follows.

4 Research method

Development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school. in this research study. Based on the development by applying the concept of Richey & Klein (2007) which consists of 3 1. Design Process 2. Development Process 3. Evaluation Process

4.1 Target group

Target group that use in this research is grade 1 , in the amount 34 students who study Wor 21105, Technology (Computational sciences), 2nd semester in academic year 2021, Kham Kaen Nakorn School, Muang district, Khon Kaen.

4.2 Researching tools

1. A web-based learning environments to promote problem solving on problem solving in computational science for secondary school**.**
2. Problem-solving measurement, built on the framework of Polya (Polya,1975).

4.3 Collecting data

1. Conduct document analysis (Document analysis) by conducting studies and analyze the principles, theories about the design of the learning environment model, consisting of the following fundamentals: Psychological base, Pedagogies base, Problem

solving thinking, Media, Technologies base and Contextual base to be used as the basis for synthesizing the theoretical framework for the development of learning environment on the network.

2. Theoretical framework creates a conceptual framework based on study and analysis of theoretical principles, research, variables, linking the relationship between theoretical principles and this research study was based on the principle of relevant research and theories can be synthesized from the theoretical framework from the basic theory is as follows. Fundamentals of problem solving (Polya, 1975), Fundamentals of Learning Psychology (Cognitive constructivist, Social constructivist, Information processing), Fundamentals of Media Theory (Media Symbol System), Fundamentals of Technology (Web base technology, Interactive), Fundamentals of Pedagogical Sciences. Constructivist learning environment, Cognitive Apprenticeship and Contextual basis.

3. Study the context of teaching and learning in the course Wor21105, Technology (Computational Science), which consists of content analysis. The subjects used in the research were on the topic of problem solving and the study of learner contexts, results of the study, contexts related to teaching and learning in the course Technology (Computational Science).

4. Synthesis of a design framework from the results of a theoretical conceptual framework study and the study of the context, it can be used as a basis for synthesizing a conceptual framework for designing a learning environment which will be the elements of the learning environment model. Then used to develop the knowledge environment on the network and assess the efficiency of the learning environment by adopting the learning environment model propose to an advisor to check.

5. Bring the learning environment on the network that have been evaluated by experts to be tested in real context.

4.4 Data analysis and statistics used

1. Checking the quality of the format by experts in content, media, and measurement and evaluation. Data analysis was performed using interpretive summaries.

2. The student's problem-solving thinking obtained from the student's problem-solving measure. Data were analyzed using statistics such as percentage, mean and standard deviation.

5 The result of research

1. Theoretical framework construct a conceptual framework based on the study and analysis of theoretical principles, research, and variables to make a link between the theoretical principles and this research study. Relevant research and theories can synthesize conceptual frameworks.

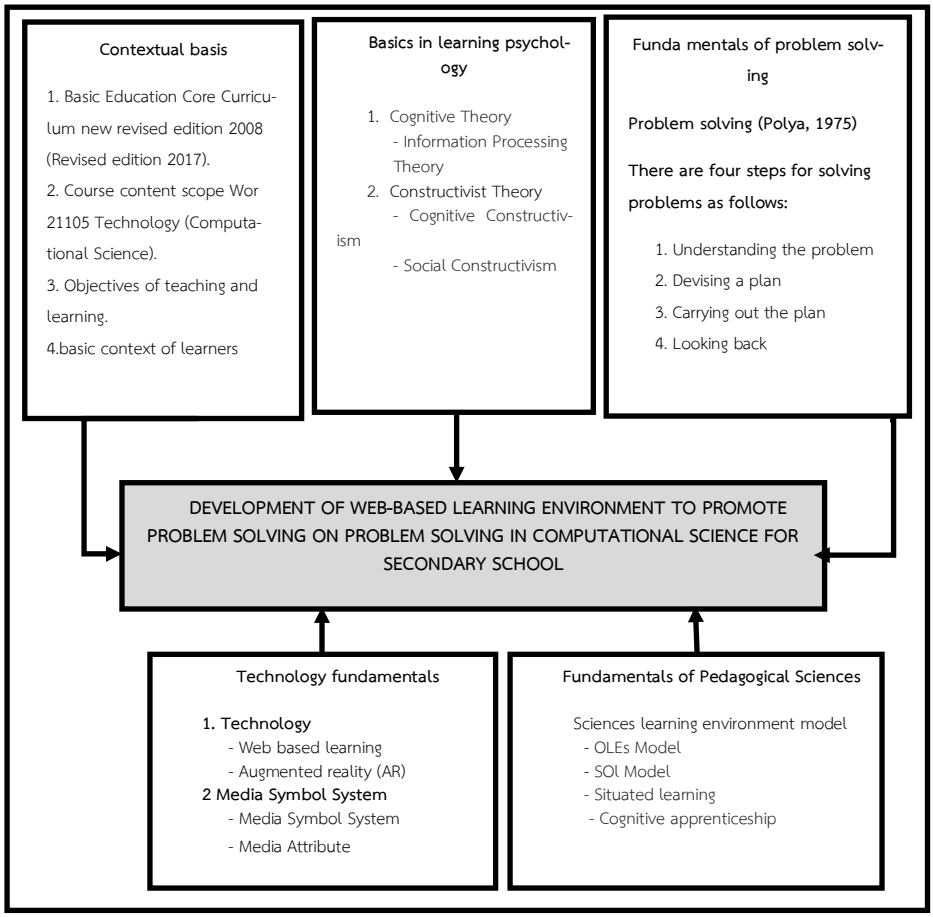

Fig. 1. A Theories framework for designing a web-based learning environment.

2. Synthesis of the design framework from the synthesis of theoretical framework of a web-based learning environments to promote problem solving on problem solving in computational science for secondary school**.** as a basis for creating a conceptual framework for designing a development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school. as shown in Fig. 2.

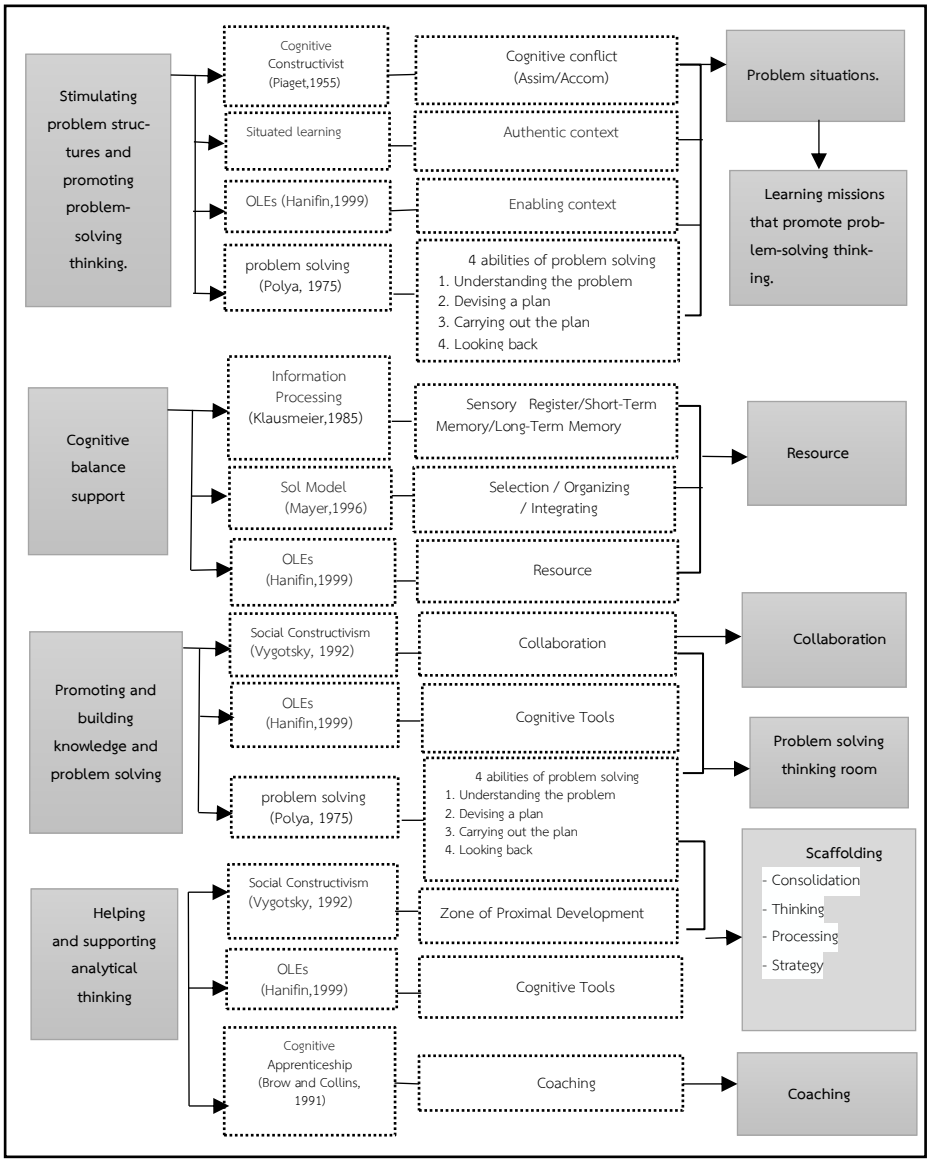

Fig. 2. A Framework of web-based learning environment model.

There is a development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school as follows:

(1) Problem situation and learning missions to promote problem-solving thinking It is a situation/task that allows learners to connect their experiences and problem-solving skills to apply them in real life. Problems are tied to create a learning task (Learning Task) for students to go down to solve problems by focusing on the learners to develop

problem-solving skills, emphasizing the importance of the appropriate learning context (Situated Learning) based on the authentic contexts, in which the problem situations aim to promote problem solving thinking is like a gateway through which the learner will enter the content to be learned (enabling context), based on the concept of Cognitive Constructivist's (Piaget, 1955) belief that learning takes place when the learner is stimulated with a problem and when students lose their intellectual balance therefore try to adjust the intellectual structure to enter the state by absorption (Assimilation) Intellectual structure and modifying the intellectual structure (Accommodation) is a link to the original intellectual structure or previous knowledge with new information and learners can adjust the intellectual structure into a state of equilibrium or be able to create new knowledge, known as learning itself. Based on Hannifin's Principles of Open Learning Environments (OLEs) (1999).

(2) Resources are sources of information. Content information that learners will use to solve problems in problem situations and tasks which from the situation that the problem will cause the learner to lose balance, it is a support for intellectual balancing by linking the learner's original cognitive structure with the new knowledge gained from the learning environment. Based on Hannifin's (1999) open learning environment design principles (OLEs), we design learning resources where learners can research resources for solving problems by using the SOI model, it can be linked to the main focus of the cognitive processes in constructivist learning as well as the use of Information Processing Theory (Klausmeier, 1985) as a theory that describes the process of information processing occurring in the human brain. It is a process of sensory register, short-term memory and long-term memory, focusing on the study of cognitive processes in the hierarchy of information processing and various knowledge calls from long-term memory to be used effectively.

(3) Collaboration is based on the Social Constructivism theory of (Lev Vykotsky, 1992), which emphasizes social interaction in learning. It is another element that encourages learners to share experiences with others to expand their perspectives. Problem Solving Collaboration encourages learners, tutors, and experts to discuss their opinions with others for designing collaborative problem solving while building knowledge. Collaborative problem solving is also an important part of modifying and preventing misunderstandings from occurring while learning, including expanding the concept.

(4) Problem Solving thinking room using Hannifin (1999) open learning environment design principles (OLEs) as cognitive tools to support student problem-solving processes to act as a medium to support, enhance or expand thinking and to help encourage students' problem solving thinking that consists of dealing with problems, problem solving planning, Polya's troubleshooting and investigation steps. (Polya, 1975)

(5) Scaffolding is based on the theory of social constructivism (Lev Vykotsky, 1992) who believes that if learners are below the zone of Proximal Development, they cannot learn on their own. The need for help is called Scaffolding, where the help base supports learners in problem solving or learning in case of being unable to complete the mission by yourself which the assistance will consist of concept building support base Methodological assistance base Process support base and strategic support base.

(6) Coaching is based on the principles of the Cognitive Apprenticeship Model (Brown & Colling, 1989), based on Situated Learning constuctiwism that has changed the role of an instructor who is responsible for transferring knowledge or imparting knowledge to a "coach" that provides assistance and advice for learners to train learners by educating learners in an objective manner giving the creation of wisdom.

3. Developing the knowledge environment on the network from the learning environment model The researcher developed it into a web-based learning environments to promote problem solving on problem solving in computational science for secondary school as shown in the following screen.

Table 1. The results of the analysis of the problem solving measure test.

	Understanding the problem	**Devising a plan**	**Carrying out the plan**	**Looking back**	**Total**
					Show total
($\bar{x}$)	11.53	5.59	6	5.15	**28.27**
S.D	0.51	0.50	0.00	0.36	**1.08**
Percentage	96.08	93.17	100	85.83	**93.77**
Total students (person)					**34**
Number of students with a passing score of 60 percent (person)					**34**
Percentage of students with a passing score of 60 percent (18 points)					**100**
Student grade point average ($\bar{x}$)					**28.27**
Standard Deviation (S.D)					**1.08**

* means a passing score of 60 percent or more (18 points)

6 Summary and Discussion

1. Design and development of web-based learning environments to promote problem solving on problem solving in computational science for secondary school in this research study based on development by applying from the concept of Richey & Klein (2007) has carried out a development research model (Developmental Research) results from research, design and development process, consisting of document research, a study of the context of teaching and learning management synthesis conceptual framework for design, designing and creating a learning environment model and improving the quality. The results of the research revealed that there are learning theories and principles that promote problem-solving thinking processes, namely Constructivist learning environment, Cognitive Apprentiship, Polya's problem-solving thinking (Polya, 1975), cognitive constructivist, social constructivist, information processing, media symbol system, and Web base technology, Interactive. From the results of the

study in the design process, the conceptual framework and elements of the learning environment design were obtained. Importantly, there are (1) problem situations (2) learning resources (3) collaborations (4) Problem solving thinking room (5) scaffolding (6) coaching.

2. A study of problem-solving thinking of learners who learn through a web-based learning environments to promote problem solving on problem solving in computational science for secondary school, a study of the results of problem-solving thinking of learners using a learning environment on a network that promotes problem-solving thinking. According to Polya's problem-solving framework (Polya, 1957), the components are: (1) understanding the problem (2) Devising a plan (3) Carrying out the plan (4) Looking back. In summary, the results of the study of problem-solving thinking of students studying in a web-based learning environment that promotes problem-solving as a result of the problem-solving questionnaire with a 4-scenario test, found that problem-solving thinking of learners who studied in a web-based learning environment that promotes problem-solving thinking of 34 students with a total score of 30 on a 30-point test, 34 students with a score of 18 up which accounted for 100 percent of the total number of students. The mean score ($\bar{x}$) was 28.27 and the standard deviation (S.D) was 1.08, which was higher than the specified threshold of 60% of the full score understanding the problem with the highest average score of 11.53 or 96.08%, followed by problem solving problem-solving planning and inspection and evaluation with a mean score of 6, 5.59, 5.15, respectively, which shows that the average score of the learners passed the criteria of 60% as specified which is consistent with the research results of Charuni Samat (2021) , Pornsawan Vongtathum (2015) , Sathaporn Wongchiranuwat (2016).

7 Suggestion

1. Should study designing a learning environment on a web-based that promotes problem solving among learners in other ways by considering that model to be consistent and appropriate to promote problem-solving thinking of learners

2. The learning environment should be arranged in accordance with the ability to think and solve problems in each area.

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References

Chaicharoen, S. (2004). *Documents for educational technology and education system development*. Khon Kaen: Department of Technology.

Chaicharoen, S. (2014). *Education design, principles, theory, and practice*. (2nd printing) Khon Kaen: Anna Offset Printing House.

Hannafin and other. (1999). *Open Learning Environments: Foundations, Methods, and Models.* In Charles M.Reigelith (Ed), Instructional Design Theories and Models: A new Paradigm of Instructional Theory. Volume II. New Jersey: Lawrence Erlbaum Associates.

Hinebaugh, J. P. (2009). *A board game education*. R&L Education.

Noisim, S and Wattanachai, S. (2020). *Effects of the learning environment on the network along the constructivist that promotes analytical thinking programming in c programming language Regarding control orders for students in grade 5*, Journal of Graduate Studies, 17(77), 50 61.

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

Samat, C. and Chaijaroen, S. (2009*). Design and Development of the Constructivist Web-based Learning Environment that Enhances Creative Thinking of Undergraduate Students.* Mahasarakham Rajaphat University Journal, 5(2), 37-47.

Srimuang, C. (2019). *Developing a learning environment on a network that promotes analytical thinking for students in grade 4 at Kudruea Kapittayakan School.* Research and Innovation Development Project to exchange *OBEC targets, fiscal year 2018*. Faculty of Education, Khon Kaen University.

Tashana Khammanee. (2008). *Knowledge for organizing effective learning processes*. Bangkok: Publishing House of Chulalongkorn University.

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). *Fostering the 21st century skills through scientific literacy and science process skills.* Procedia-Social and Behavioral Sciences, 59, 110-116.

Vongtatham, P. (2015). *Creation of problem solving thinking in 21st century Learning*. Education Journal, Khon Kaen University, 38(2), 112-117.

Wongchiranuwat, S. (2016). *The effect of the learning environment of virtual technology on the network in line with constructivism that promotes creativity about graphic design for students in grade 3*. Master of Education Thesis Department of Educational Technology graduate school, Khon Kaen University.

Vygotsky, L.S. (1978). *Mind in Society. The development of higher psychological processes. Cambridge,* MA: Harvard University Press.