The Design and Development of Digital Learning Environment to Enhance Students' Problem Solving

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Abstract: Problem-solving skills let students apply what they learn instead of just recalling information. It is a valuable skill in a wide range of fields. Knowing how to solve problems enables students to think critically. The purposes of this research were to: (1) design and develop constructivist web-based learning environment to enhance students' problem solving, and (2) to examine the students' problem solving. The target group was 33 students who were studying in grade 10 in the second semester of the 2015 academic year at Demonstration School of Khon Kaen University Secondary School. The research methodology was one shot case study. The data were collected and analyzed both quantitatively and qualitatively. The quantitative data analysis included learning achievement for problem solving achievement through the use of basic statistics which are percentage, mean, and standard deviation. The qualitative data analysis included problem solving through protocol analysis. The results revealed that: (1) the constructivist web-based learning environment to enhance students' problem solving. These included (1) Problem base (2) Information Resource (3) Cognitive Tools (4) Collaborations Tools (5) Problem solving support tools (6) Related cases (7) Coaching (8) Scaffolding. And (2) Students' problem solving that the student show process in 4 step: 1) Articulate problem space and contextual constraints, 2) Identify and clarify the cause of the problem, 3) Generate possible problem solutions, 4) Select problem solution to problem solving and 87.87% of the total learners passed the 70% criterion of the specified scores.

Keywords: Learning environment, problem solving, constructivist, 21st century skills

1. Introduction

The development of knowledge and technology in current society is changing rapidly, as a result of education, efficiency and persons with knowledge of soils and various information. To develop and solve problems faced by them. In the current context, education has changed from teaching to rote teaching the students the knowledge with the attendees themselves. By learning environment for the students to face the situation in the context of learning and learning content that can be linked to the actual context. Educational policies of Thailand stressed that the students can learn and develop themselves. Focus on learning to learn skills, thought processes, to manage, to face the situation, and the application of knowledge to prevent and solve problems, learn from experience, practical training possible. It is also consistent with the core curriculum for basic education. Which defines the competencies of the learners focused on the ability to solve problems on the basis of rational, moral, and information. As well as understand the relationship of events and changes in society, the pursuit of knowledge, application of knowledge used in the prevention and resolution and the powerful. And led to the creation of knowledge or information to make decisions about themselves and society appropriately.

So learning the science needed to support the learning activities linked to knowledge to the process. To develop the idea of learning the key skills in researching and creating knowledge through a quest for knowledge, solve problems systematically, can make decisions using a variety of data and create knowledge that ensures accountability. Well skilled in the use of technology in information search and management. In the context of studying biology that are complex, difficult to understand, learning content with purely technical basis, resulting in the inability to understand or to know the

contents of the unit. Learning Management need to learn the skills that created self-knowledge. The situation provoked by the context of the neighborhood and the students used to learn. The objective was to give the students' knowledge of processes and solutions can link new knowledge with prior knowledge to use in learning other content. The learning management is in line with the constructivist theory, believes that learning is a process that takes place inside the learner. Learners created knowledge of the relationship between what is seen with the knowledge that has come before, and try to understand about events and phenomena found their way to build a cognitive structure. Learning takes place when the students were motivated by problems that cause cognitive conflict, known as the disequilibrium. Students will try to restructure its intellectual equilibrium or learning, to balance the intellectual class must discover and seek answers for themselves by the second process is assimilation and accommodation, which the student is required to take a variety of information on the intellectual balance. So learning to be successful, students need to practice their skills in information, especially information technology, to help in learning. To help the students have sufficient information analyzed, classified to link new knowledge with prior knowledge. Design learning environments that use technology as a base, it is a good chance that students will be able to use the network for advanced troubleshooting. This research aims to develop an educational environment that promotes learning problems of students. By integrating learning theory, pedagogy, teaching, and digital media features. Moreover, the problem-solving skills of students learning with digital learning environment.

2. Methodology

The study consists of 33 students who were studying in grade 10 in the second semester of the 2015 academic year at Demonstration School of Khon Kaen University Secondary School, Thailand were all enrolled for the Biology course. The objective of this course was solve problem based on knowledge about the human digestive system. The skill test was adapted from Jonessen (1997). The skill test aimed to gauge their articulation a problem space and contextual constraints, identification and clarification the cause of the problem, generating possible problem solutions, and selection the problem solution to problem solving after learning with digital learning environment to enhance students' problem solving. The open-ended questions and problem-solving tasks was added to skill test. The research is qualitative data, the interpretation, scoring rubric and the average were used to analyze the data in this study.

3. Results

The design and development of digital learning environment that encourages students to the problems solving of the digital environment designing framework.

The design and development of digital learning environment to enhance learner's problem solving skill was found that the designing framework of digital learning environment which the researcher synthesized under the theoretical framework based on constructivism learning theory, pedagogy and learning model, technology for learning concept, and student's learning context comprised (1) Problem base (2) Information Resource (3) Cognitive Tools (4) Collaborations Tools (5) Problem solving support tools (6) Related cases (7) Coaching (8) Scaffolding.
　　　Regards the designing framework, the research used it to develop the digital learning environment to enhance learner's problem solving skill which its components were;
1) Problem base: based on Cognitive Constructivism and CLEs which designed the situation on authentic context and complexity, and presented in problems situations along with learner's context in order to help the learners to be able to refer or connect to their own experience . This designed problem situation and learning tasks would have to enhance their problem solving skills which applied the design by problem solving principle of Jonessen (1997). In this study, the situations were designed concerning 4 main content as oral digestion, gaster digestion, small intestine digestion, and nutrient absorption as the situation samples in "Jack's Chewing Story" (content concerning oral digestion) presented in Figure1 and Figure2.

Figure 1. Main page of Problem base

Figure 2. Situation samples in "Jack's Chewing Story" (content concerning oral digestion)

2) Information Resource: In order to investigate problems, learners need information with which to construct their knowledge and formulate hypotheses that drive the manipulation of the problem space we determine provide information sources are an essential part of learning environment that provide learner-selectable information just-in-time. The World Wide Web was used for this study, is the default storage medium, as powerful new plugins enable students to access multimedia resources from the net. These learning environments, however, embed hypertext links to Web sites based on the surface features of the site (Cunningham, Duffy and Knuth, 1993). These may include text, documents, graphics, video, and animations that are appropriate for helping learners understand the problem and its principles. Figure 3 showed the main page of Information Resource which inserted the link to minor content and Figure 4 showed the sample of Information Resource.
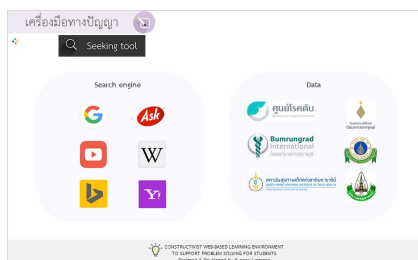

Figure 3. Main page of Information Resource

Figure 4. Information Resource

3) Cognitive Tools: Cognitive tools are generalizable computer tools that are intended to support and promote specific kinds of cognitive processing (Kommers, Jonassen and Mayes, 1992). They are cognitive tools that are used to visualize, organize, or displace thinking skills. Some intellectual tools replace thinking, while others promote students in constructive processing of information that would not occur without the tool. So the designing of cognitive tools consisted of (1) Seeking tool: supported the learner to search related information and addressed information reposition by search engines such as Google and wiki, (2) Collecting tool: helped them to collect related information by downloading on network, (3) Organizing tool: helped them to categorize information such as Google Docs and Word Online, and (4) Integrating tool: helped them to integrated information in according with their thinking concepts such as Google, Keep Blog, Google+ as Figure 5 presented the sample of Cognitive tools.

4) Collaborations Tools: Learning most naturally emerge not in isolation but by group of learners who working concurrently to solve problems. Learning environment should allow access to shared information and shared knowledge-constructing tools to support student to collaboratively construct socially shared knowledge. So in this study, the Collaborations Tools was design as Collaboration Room where provided them place to interchange thinking concepts, opinions, and solutions of their own and group. It was designed in Facebook group where they got familiar and were skillful of using. Figure6 presented the main page of Collaborations Tools
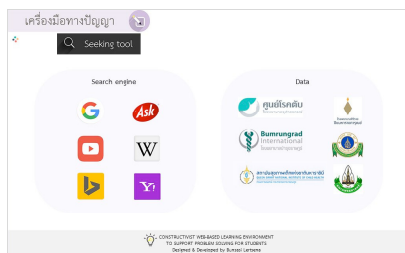
Figure 5. Seeking tools

Figure 6. Main page of Collaborations Tools

5) Problem solving support tools: The researcher designed the tool to enhance the learner's problem solving which mainly on learning with the authentic situations which could help them to practice problem solving skills. Problem solving principles of Jonassen (1997) which comprised (1) problem context and its limitation, (2) address the real problems and its causes clearly, (3) consider the possible solution, and (4) select the solution to be used to solve such problems; was hence used to design the web-based learning environment in form of Problem Base and learning tasks. Figure 7 presented Problem solving support tools.

Figure 7. Problem solving support tools

Figure 8. Related cases

6) Related cases: Understanding any problem requires the experience and generating mental models of it. What novice students lack most are experiences. This lack is particularly critical when trying to solve problems. So, it is important that learning environment provide access to a set of related experiences to which novice learners can refer. As that so, the researcher arranged the learners to be able to learn through experiences concerning the problems, presented complex knowledge via Case Study in the context of diseases or sickness conditions related problem situations. The learners then knew causes, solutions, and treatments as well as diagnosis which they could use to refer and connect to related experiences in order to solve such problems. This could enhance them to be able to solve a new problem in similar context. Figure8 presented the sample of Related Case main page.

7) Coaching: The researcher designed 2 communication channels as confronting in authentic situations where learning activity inserted, and as network communication where with learning activity as Live Chat, and asynchronous which contacted the experts in different time as in form of Facebook group "Coach". Figure9 presented portal of coaching.
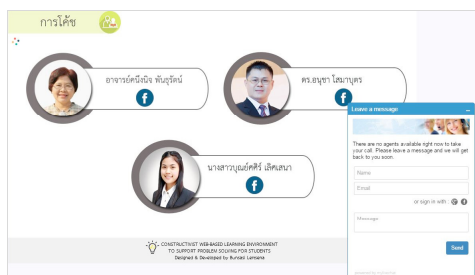

Figure 9. Portal of coaching

Figure 10. Conceptual Scaffolding

8) Scaffolding: The scaffolding concept show any kind of engage for cognitive activity that is provided by an adult when the leaners are performing the task together (Wood and Middleton, 1975). So, the researcher used such principle to design the component named "Scaffolding" which consisted of Conceptual Scaffolding, Metacognitive Scaffolding, Procedural Scaffolding, and Strategic Scaffolding which showed the sample of Conceptual Scaffolding in Figure 10.

Research results of learner's problem solving skill learned with digital learning environment enhancing students' problem solving skill

This results were from the data analysis through Descriptive Statistic and Protocol analysis through an Interview which found that the average solving score of the learners who learned with the learning environment was 15 scores or 75 percent of the entire scores. 87.87 percent of them passed the standard. And their problem solving skills recorded via the interview was found that they had 4 processes as (1) stated problem context and its limitation, (2) addressed the real problems and its causes clearly, (3) considered the possible solution, and (4) selected the solution to be used to solve such problems which based on the applying of Jonessen principles (1997).

4. Conclusion and Discussion

Design and development of constructivist web-based digital learning environment to enhance students' problem solving.

This study, the researcher designed and developed based on the importance of constructivism theory and web-based learning by considering on media attributes and media symbol system, and evaluating the environment according to the web-based learning environment evaluation of Sumalee (2014) in 5 aspects as products, context of use in authenticity, learning achievement, cognitive ability, and learner's opinion. This consisted of 8 components as 1) Problem base which provoke the students to feel as if they were part of the situations, feel enthusiastic, and try to find how to find the answers from various resources. This consists with constructivism learning theory which believes that learners are knowledge constructer by being an active learner while in disequilibrium and they try to adjust their schema by method of assimilation or interpret or receive the data from the environment into their schema, 2) Information Resource which based on cognitivism theory for example, conclude the key content in forms of graphics showing the relationship of its content in order to help them to understand, in forms of pictures and animation to help them to have attention, 3) Cognitive tool designed to support their problem solving based on OLEs in order to complete tasks in complex, new, and authentic situations; consisted of Seeking tool, Collecting tool, Organization tool, and Integrating tool, 4) Collaborations Tools to help them to collaboratively work in solving a problem, change opinions, enlarge thinking concepts, and correct the misunderstanding, 5) Problem solving support tools to provide them to practice to solve a problem in a case study in expertized perspectives based on stage of problem solving (Jonassen, 1997; Jonassen, 2011) as (1) Articulate problem space and contextual constraints, (2) Identify and clarify the cause of the problem, (3) Generate possible problem solutions, and (4) Select problem solution to problem solving, 6) Related cases based on CLEs to support their learning as helping the to remember meaningfully and presenting complex knowledge via various problems in order to connect with the confronting problem, 7) Scaffolding to support them to solve a problem with disability to complete a task which believes that when the learners are under the Zone of Proximal Development, they need to have help, 8) Coach or the changing of teacher role from transmitter to coach of problem solving and discovering continuously which the learners could have suggestion or consultant to have more understanding as well as evoke them to discover knowledge consisted with Suchart (2010), Issaa (2009), and Charuni (2009). The conclusion was that the web-based learning environment enhanced the learners to construct their own knowledge by being an active learner, supported them to have learning process and collaboration, helped them to enlarge schema and learned meaningfully. This was designed based in constructivism theory, cognitivism theory, problem solving skill, school context, as well as media attributes and web-based learning in order to be rich for the learners to learn in learning activities and enhance them

to have the desired characteristics and finally the learners who were ready to use learning media would get success in learning.

Solving the problem of students who learning with constructivist web-based digital learning environment to enhance students' problem solving.

Regards the research results, the data were analyzed using descriptive statistics and protocol analysis via the interview, showed that the problem solving of the students showed average score as 15 or 75 percent of the total. 87.87 percent of them passed the standard. And their problem solving skills recorded via the interview was found that they had 4 processes follows as stage of problem solving (Jonassen, 1997). These findings might affect from the designing of constructivism web-based learning environment enhancing problem solving skills based on constructivism theory which mainly on knowledge construction by providing the situation to make them be in disequilibrium and require to be in equilibrium or construct the new knowledge. As well as the designing of learning tasks to enhance them to practice to solve a problem and reason which is the enhancing of cognitive process consistent with content of human digestion which complex and affect to their solving skill. The Problem Base was design in complex and authentic situations which provided them to confront the problems and search data towards conditions or diseases in digestion system. While they were in authentic situation, they got in meaningful which they could connect their own prior knowledge and look for new knowledge to solve a problem. Such process requires them to be an active learner to have skills as analytical thinking, hypothesis thinking, reasoning, assessing and applying skills to be used in solving a problem. Regards such findings, the learning with such constructivism web-based learning environment enhancing problem solving skills by proving them to be active learners via problem solving in authentic situations could enhance them to have skills throughout their life as well as new knowledge and technology. The enhancing of learner's thinking skills which consistent with the learning management of The Demonstration School of Khon Kaen University (Education) - Secondary School which highlights on learner's knowledge construction consistent with the study of Saksan (2011) and Problem Solving of Suchart (2012) which designed the learning environment to enhance the learners to solve a problem and construct knowledge on their own.

Acknowledgements

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