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The Development of Experimental Set on Internet of Thing (IoT) Based on Constructivist Theories to Enhance Ill-Structured Problem Solving for Engineering Students

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Abstract: Ill-Structured Problem Solving is the most importance skill for Engineering in 21st century. Thus, the purpose of this research was to synthesize the designing framework and construct the experimental set on Internet of Thing (IoT) based on constructivist theories to enhance ill-structured problem solving for engineering students. Document analysis and survey research were employed in this study. The result revealed that: 1) The result of designing framework consisted of 5 stages and 7 elements, were as follows: (1) Activating cognitive structure and promoting Ill-structured problem solving (2) Supporting for adjusting of cognitive equilibrium (3) Supporting for enlarging cognitive structure (4) Enhancing Ill-structured problem solving (5) Supporting and encouraging knowledge construction and 7 element as following: (1) Problem Bases, (2) Learning Resources, (3) Social Collaboration Center (4) Cognitive Tools (5) Ill-structured problem solving Center (6) Scaffolding center (7) Coaching Center. 2) The Prototyping of experimental set on Internet of Thing.

Keywords: Constructivist theory, ill-structured problem solving, Internet of Thing (IoT).

1. Introduction

The advancement in technology has been exceptionally fast in 21st century. In January 2016, The World Economic Forum published "The Future of Job," (WEF, 2016) and stated that needed skill in the future will be complex problem-solving capability, namely, the ability to resolve novel or ill-defined problems under complex circumstances in reality. That is consistent with the workplace engineering problems because this problem possess conflicting goals, multiple solution methods, non-engineering success standards, non-engineering constraints, unanticipated problems, distributed knowledge, collaborative activity systems, the importance of experience, and multiple forms of problem representation (Jonassen, 2006).

However, at present instructional management focuses on transmitting and memorizing information. Moreover, the problems that engineering students found in the classroom were different with workplace engineering problems. This results in lacking of ill-structured problems solving and information seeking skills of the learners.

For the above reasons, it is necessary to adapt the learning strategies to meet the 21st century learners' characteristics. Therefore, the instruction design must be changed in order to enhance ill-structured problems solving and information seeking skills and knowledge construction rather than passively receive the knowledge. Instructional Design Theory (ID Theory) was used in this design. Crucial theories used as foundation were Constructivist theories: Cognitive Constructivism and Social Constructivism, Cognitive theories: Information processing and the Ill-Structured problems solving. These theories may help the knowledge construction and Ill-Structured problems solving of the learners, especially in the course of Industrial Electronics which students need to study about sensors that are used in industrial. Moreover, the media attribute and symbols system of

web base and Internet of Thing (IoT), the network of electronic devices which enables these things to connect and exchange data, comprises of hyperlink may support the knowledge construction and ill-structured problems solving.

Thus, researchers realize the importance of development the experimental set on Internet of Thing (IoT) to control sensors based on constructivist theories to enhance ill-structured problem solving for engineering students. This designing framework and experimental set on Internet of Thing to control sensors may help designer to effectively design the experimental set.

2. Research purposes

2.1 To synthesize the designing framework of constructivist web-based learning environment model to enhance ill-structured problem solving for engineering students.

2.2 To develop the experimental set on Internet of Thing (IoT) to control sensors based on the designing framework of constructivist web-based learning environment model to enhance ill-structured problem solving for engineering students.

3. Research Methodology

3.1 Research Design

The literature review and survey research ware employed in this study.

3.2 Target Groups

Target groups in this study as following details: (1) 3 experts for evaluation of the designing framework included 1 content expert, 1 instructional designers and 1 instructional media expert. (2) 30 undergraduate students of Electronics and Telecommunication Engineering department, Rajamangala University of Technology Isan, Khon Kaen campus who enrolled in a course of Electronics Industrial. The 1st semester, 2018 academic year.

3.3 Research Instruments

The instruments in this study as following details: (1) The expert review recording for examination the quality in various domains as follows: learning contents, instructional design, and media. (2) The recording form for synthesis of the designing framework of constructivist web-based learning environment model to ill-structured problem solving for engineering students. (3) The construction tools for construct the experimental set on Internet of Thing (IoT) to control sensors include digital multimeter, oscilloscope and DC power supply.

3.4 Data collecting and analysis

The researchers collected the data as follows: (1) Synthesis of designing framework of constructivist web-based learning environment model to ill-structured problem solving for engineering students. The data were collected by using the recording form for synthesis of the designing framework. Summarization, interpretation and analytical description were used to analyze the data. (2) Development of Experimental Set on Internet of Thing (IoT). The data were collected by using the recording form for synthesis of the Experimental Set designing framework. Summarization, interpretation and analytical description were used to analyze the data.

4. Research Results

The designing and development of the Experimental Set on Internet of Thing (IoT) Based on Constructivist Theories to Enhance Ill-Structured Problem Solving for Engineering Students are follows:

4.1 Synthesis of Design framework

According to this study, the findings of synthesis of the designing framework of constructivist web-based learning environment model to ill-structured problem solving for engineering students showed 5 stages were as follows:

- Activating cognitive structure and promoting ill-structured problems solving: The first crucial base of designing framework was activating cognitive structure, problem solving, it illustrated the underline theories used in design the component called "problem base" of the learning environments for enhancing Ill-Structured Problems solving. The underlined theories used for activating cognitive structure were as follows: Cognitive constructivism (Piaget, 1992); cognitive conflict, situated learning (Brown, Collins & Duguid, 1989); Authentic context. These theories were transformed into practice as problem situation in order to induce the learners into discovery learning process. The 7 steps of ill-structured problems solving (Jonassen, 1997) as following: Step 1: Learners Articulate Problem Space and Contextual Constraints Step 2: Identify and Clarify Alternative Opinions, Positions, and Perspectives of Stakeholders Step 3: Generate Possible Problem Solutions Step 4: Assess the Viability of Alternative Solutions by Constructing Arguments and Articulating Personal Beliefs Step 5: Monitor the Problem Space and Solution Option Step 6: Implement and Monitor the Solution Step 7: Adapt the Solution were transformed into practice as learning task in order to promote problem solving. This may help activating cognitive structure and problem solving of the student. The designing framework of the activating cognitive structure and promoting ill-structured problems solving as follow figure 1.

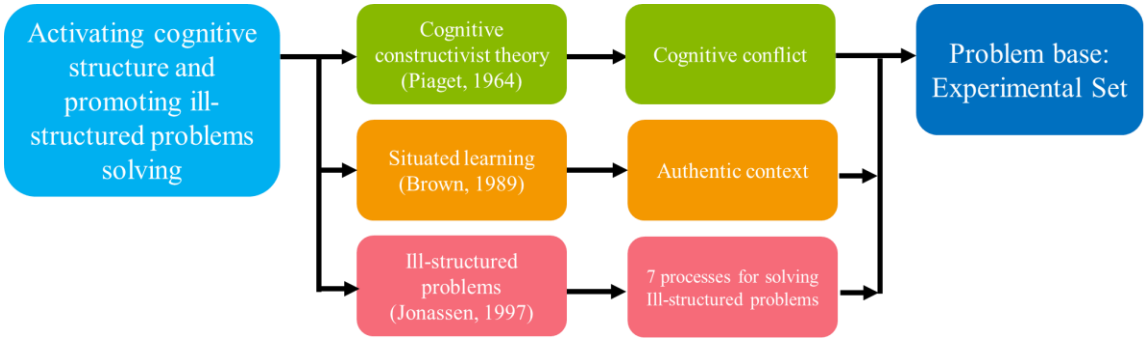

Figure 1. Activating cognitive structure and promoting ill-structured problems solving

- Supporting for adjusting of cognitive equilibrium: The second crucial bases of the designing framework was supporting for adjusting of cognitive equilibrium, it illustrated the underlined theories used to design the component called "Learning Resources" of the learning environments to enhance ill-structured problem solving. The underlined theories used for supporting for adjusting of cognitive equilibrium were as follows: information processing theory (Klausmeier, 1985); sensory register, short-term memory, long-term memory: cognitive load theory (sweller, 1994); chunking, hierarchical network and media attribute symbol system of multimedia; still pictures, motion pictures, text, sound: schema theory; schema as context, schema as network: SOI model (Mayer, 1996) selecting, organizing, integrating; mental model theory; conceptual model. These theories were transformed into practice as learning resources in order to provide information for the learners to construct the knowledge. This may help the learners processing information effectively and understand easily.

- Supporting for enlarging cognitive structure: The third crucial bases of the designing framework was supporting for enlarging cognitive structure, it illustrated the underlined theories used to design the component called "Social Collaboration Center". The underlined

theories used for supporting for enlarge cognitive structure were as follows: Social constructivism (Vygotsky, 1962); language, culture and society. These help support learners to share experiences, multiple perspectives, and adjust misconceptions. Cognitive tools (Hannafin, 1999) comprise of Seeking Tool, Collecting Tool, Organization Tool, Integrating Tool, and Generation Tool. These 5 tools help support learners to enable and facilitate the cognitive processing associated with open-ended learning. This may help learners supporting for enlarging cognitive structured.

- Enhancing Ill-Structured Problems solving: The fourth crucial base of designing framework was Support for Enhancing for ill-structured problem solving Skills, it illustrated the underline theories used in design the component called "enhancing ill-structured problem solving center". The underlined theories used for Supporting for enhancing ill-structured problem solving skills were as follows: ill-structure Problem (Jonassen, 1997).

- Supporting and encouraging knowledge construction: The fifth crucial base of designing framework was Support for promote and assist knowledge construction, it illustrated the underline theories used in design the component called "Scaffoldings" and "Coaching". The underlined theories used for promote and assist knowledge construction were as follows: Social Constructivist (Vygotsky, 1978): Zone of proximal development. OLE (Hannafin, 1999): Conceptual Scaffolding, Strategic Scaffolding, Metacognition Scaffolding. Cognitive apprenticeship (Brown, 1989): Coaching. These theories were transformed into practice as learning resources in order to provide information for the learners to construct the knowledge. This may help promote and assist learner.

4.2 Develop experimental set on Internet of Thing: case study for problem base

In the workplace engineering problems, problems are ill-structured and complex (Jonassen, 2002). Thus, the students should be encouraged to practice ill-structured problems solving. The "problem base" is used for activating cognitive structure by stimulate the students into disequilibrium. After that, the students will find information for adjust cognitive structure into equilibrium by assimilation or accommodation. So, in this design was provided the ill-structured problem and authentic context, which is the real world of using industrial. For instance, Node MCU, power supply, ultrasonic sensor, gas sensor, motion sensor, flame sensor, light sensor, temperature & humidity sensor, relay and LCD.

Thus, the experimental set on Internet of Thing to control sensors and the designing framework were adapted from the ill-structured problem solving process (Jonassen, 1997). The "problem base" contains the situation with ill-structured problem. Then, designing tasks and engineering students will be asked to solve problem tasks by follow below processes.

- Learners articulate problem space and contextual constraints: The first step in the ill-structured problem solving process is identifying the appropriate problem space which contain all of the possible states of the problem, the problem operators, and the problem constraints. Then, engineering students will write the problem space into the experimental handbook.

- Identifying the real problem: After engineering students identify the appropriate problem space. They have to analyze and identify what does the problem really exists. In this step, they should identify all stakeholders and their goals because ill-structured problems usually have divergent or alternative solutions. Thus, they should identify all of the various perspectives, views, and opinions on that problem, and then, identify the real problem. After that, they must record into the experimental handbook.

- Generate Possible Problem Solutions: The ill-structured problems possess multiple solutions because there are multiple representations of the problem. The engineering students will build their own mental model of the problem which can identify and select or synthesize a solution. After that, they must record into the experimental handbook.

- Assess the Viability of Alternative Solutions: For this step, engineering students will use the Experimental set of Internet of Thing for assessing the possible solution to test their concepts of controlling sensors or hypothesis by using experimental set as a simulation tool. The experimental set will contain situation in real world such as damage sensor which cannot send data to the server and record into the experimental handbook.

- Planning and monitor the Problem Space: After select the possible solution from step 4, they should make problem solving plan carry out that plan. For instance, they must planning cost and human resource for repairing. Then, setup schedule time with agreement for all department. After that, provides evidence of metacognition and record into the experimental handbook.

- Implement and Monitor the Solution: While engineering students implement the solution, they should monitor performance of sensors which they repaired or controlled such as checking the LED indicator on the sensor that work properly and record into the experimental handbook.

- Adapt the Solution: After Implementation the solution, engineering students will get the feedback from previous step. And then, adjust and adapt it based on feedback and record into the experimental handbook.

5. Conclusion

The designing framework of the constructivist web-based learning environments model comprised of 5 stage as following: 1) Activating cognitive structure and promoting ill-structured Problems solving, 2) Supporting for adjusting of cognitive equilibrium, 3) Supporting for enlarging cognitive structure, 4) Enhancing ill-structured problems solving and 5) Supporting and encouraging knowledge construction. This finding was consistent with Sakesun, Y. (2011); Suchat, W. (2010). These previous research found that the students showed their ill-structured problems solving and the framework of constructivist web-based learning environment model used ill-structured Problems solving foundation of the design. As for this research finding may be the result of Instructional Design Theory (ID Theory) that used underlined theories especially the problem solving theory (Jonassen, 1997) as the foundation of the design. This was shown in the designing framework of the Constructivist web-based learning environments model to enhance ill-structured problems solving. This may help learners to enhance ill-structured problems solving. In addition, found from assessment by experts. As mentioned findings can be supported the designing framework of the constructivist web-based learning environment model to enhance ill-structured problems solving.

The experimental set of on Internet of Thing (IoT) was applied from the ill-structured problem solving process (Jonassen, 1997) as following processes: 1) Learners articulate problem space and contextual Constraints. 2) Identifying the real problem. 3) Generate possible problem solutions. 4) Assess the viability of alternative solutions. 5) Planning and monitor the problem space. 6) Implement and the solution. 7) Adapt the solution.

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