Development of Online Instruction with Problem Based Learning on Introduction to Programming to Promote Analytical Thinking Ability for Undergraduate Students in Computer Education Program

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ABSTRACT

Problem-based learning can help to promote higher order thinking skills in students and nurture their analytical thinking and problem-solving ability. Participating in a self-directed and collaborative learning process helps them to develop systematic thinking skills. The purposes of this research were to 1) develop and validate the efficiency of online instruction and problem-based learning on an introduction to programming course and, 2) to study the analytical thinking ability of students before and after learning by this method. The sample group was undergraduate students at Nakhon Ratchasima Rajabhat University studying computer programming in the second semester of the 2018 academic year. The sample group was divided into one group was for finding out the efficiency of the lesson; it comprised 31 students and another group was 30 students for a purpose of making a comparison to find out the analytical thinking ability before and after they participated in teaching and learning activities based on the problem-based approach. Findings include: 1) the efficiency of activity knowledge is equal to 80.16/80.32 and 2) the level of analytical skills after learning is higher than it was before learning.

Keywords: Online Instruction, Problem-Based Learning, Analytical Thinking Ability,
Introduction to Programming

1. INTRODUCTION

Student-centered learning shifts the focus of instruction from the teacher to the student and can promote their higher order thinking skills. The student learns independently with support from a facilitator [1]. The facilitator must give priority to 'learning' and focus on more than just 'teaching'. To develop the skills necessary for the 21th century and so they can respond to a rapidly changing society students should learn critical thinking, problem solving, communication and collaboration skills. Analytical and problem-solving skills are important for them to be able to understand and resolve difficulties in various situations [2]. This is in accordance with constructionist theory, which states that self-building knowledge is attained by learning by doing. That is, students learn by solving problems and connecting new knowledge with existing knowledge, for further improvement [3]. This sits alongside the advancements in technology that connect people in the digital age.

In present, digital literacy refers to relevant skills that enables one to adopt and makes use of the tools, equipment, and current technology and digital native refers to people who were born in the digital age, who should be armed with knowledge, provided with training on analytical thinking, including communication and management information for digital age [4]. Therefore, in an education field, it is needed to promote skills for students to adjust themselves into a rapidly changing world, that is from a traditional education to a digital learning, where students can learn by using information technology anytime, anywhere. Digital learning can be done by knowledge transforming process, building learning environment and preparing students for readiness to learn relevant skills and to think things of digital. It is teaching and learning [5] that will allow students to have relevant skills and knowledge for lifelong learning [6].

In learning on an internet network, the online instruction is a tool for learning through web-technology. Students can study in self-directed and collaborative in learning activities. The instructor must design the lesson in accordance with the learning facilities applied to the content by using multimedia that is interesting and stimulating for learning [7]. Researchers studied and conducted a literature review and found that many subjects related to programming emphasis principles and theories of programming language in order to develop as a system program blended many knowledges to apply them together such as mathematic and logic, array, iteration, structure control etc. All of them can be develop on online instruction in association with problem-based learning. In the context of learning, it was found that one of the problems in class learning founded students are understand in principles and theories of introduction programming, but they are not enough able to synthesize and analyze in problems-based. Researchers has an opinion using online learning as an intermediary in learning blend with problem-based learning to promote student learn in self-directed and by doing so students can practice their step by step thinking skills.

From the reasons as mentioned above, researchers appreciate to important of learning for efficiency learning by using design learning with cycle of problem-based learning in 4 steps: 1) Understanding the Problem 2) Learning stage 3) Solving the Problem and 4) Reflecting [8]

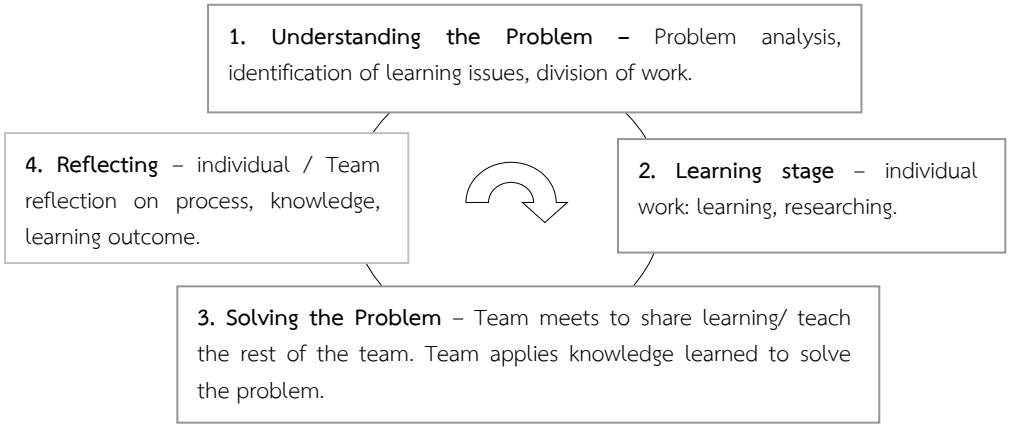


Figure 1 The PBL learning cycle

This learning model comprises main elements that covered learning followed all purposes and promoted efficiency to learn in self-directed and promote develop thinking skills and analytical thinking skills. According to Bloom [9] analytical thinking is identifying content into different parts which can explain the importance of that component and associate the relationship consists of 3 elements 1) analysis of element 2) analysis of relationship and 3) analysis of organizational. The learning management is to be direction to effective teaching and learning. The researcher is interested in studying and developing online instruction by organizing teaching and learning using problems as a base in introduction programming to promote analytical thinking for undergraduate students Nakhon Ratchasima Rajabhat University to promote problem solving skills and analytical thinking for students and they can be used for further benefits.

2. PURPOSE

1) To develop and validate the efficiency of online instruction with problem-based learning in introduction to programming to promote analytical thinking ability in undergraduate students of computer education program.

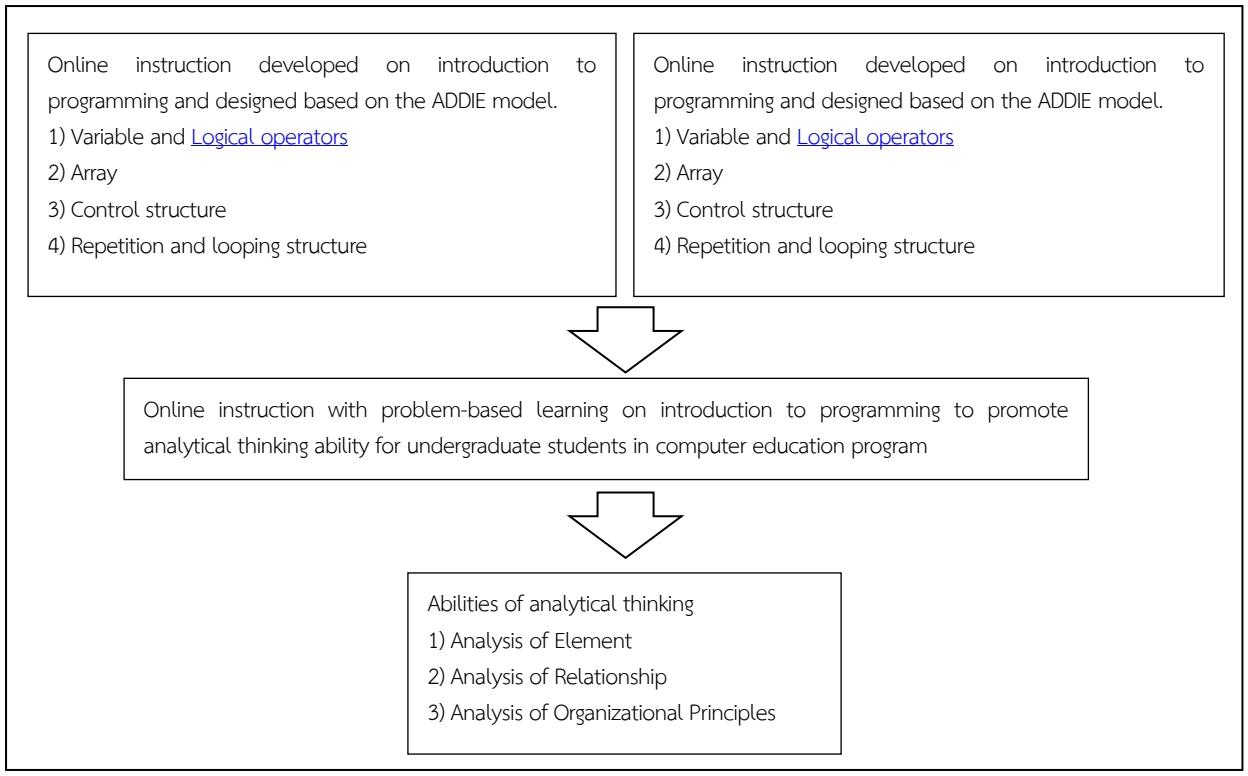
2) To compare analytical thinking ability between before and after learning using online instruction with problem-based learning in introduction to programming to promote analytical thinking ability for undergraduate students in computer education program.

3. RESEARCH HYPOTHESIS

1) The efficiency of online instruction with problem-based learning in introduction to programming to promote analytical thinking ability for undergraduate students in computer education is based on the efficiency criterion of E1/E2 which is higher than 80/80.

2) The analytical thinking ability after learning is higher than before learning using online instruction with problem-based learning in introduction to programming to promote analytical thinking ability for undergraduate students in computer education program is significant at the level of 0.05.

4. CONCEPTUAL FRAMEWORK



5. METHODOLOGY

1) Population and Samples

The population was 178 undergraduate students on a computer education program during the final semester of the 2018 academic year in the faculty of education at Nakhon Ratchasima Rajabhat university. The sample group was divided into one group for a purpose to study online instruction of problem-based learning for find out the efficiency of online instruction sample group by using purposive sampling method to study online instruction of problem-based learning group of 30 students and another sample group comprised 31 students by using simple random sampling method for a purpose of making a comparison to find out the analytical thinking ability before and after they participated in teaching and learning activities based on the problem-based approach.

2) Research instrumentations

1. The lesson plans on introduction to programming using problem-based learning.
2. Instruction online in Learning Management System Moodle
3. The analytical thinking ability test on introduction to programming using problem-based learning.

3) Research procedure

Phrase I. Development of a Research Instrument

1. The online instruction in introduction programming is developed by following the problem-based learning cycle [8] and designed based on five steps of the ADDIE Model: Instructional Design Model [10] as follows:

1.1 Analysis: Study of relevant principles and theories and a literature review. Followed by data collection and analysis of the online instruction in introduction programming and an analysis of problem-based learning. The study begins by specifying the target group and choosing the teaching topics. The content that must be learned via online instruction using an appropriate learning model and activities is considered and developed following the four steps in the problem-based learning cycle as follows: 1) Understanding the problem: this begins with a definition of the problems in the four lesson plans. The instructor describes the causes of the problems and provides guidelines for solving them. Next, the students are divided into groups of six. The students participate in various situations and share in self-directing the work in their own groups. The instructor is on hand to provide support by responding to students' questions about the problems. 2) Learning stage: students research and study the assigned problems and carry out further programming coding by specifying the duration and practice of a problem. For one week they research their own issues and collect data for group working. 3) Solving the problem: the data obtained from the study is analyzed within the group and the problem is solved by programming. While the students are studying, the instructor has to provide guidelines and monitor the learning. The final step is 4) Reflecting: in the following week, the students present the methods they used to solve the problems together and their findings.

1.2 Design: Adoption of the analysis of the results to design the learning and activities according to the learning objectives, the lesson structure and content, the lesson plans, and the learning activities and assessment. Next, present the working processes for each part of the content and sort, priorities and arrange the content so it is consistent with the learning activities.

1.3 Development: Adoption of the design and development of instruction online in Learning Management System Moodle with problem-based learning for four lessons, consisting of 1) Variable and logical operators, 2) Array, 3) Control structure and 4) Repetition and looping structure. Next, design the media layouts to make the learning clear, appropriate, and attractive, including the interface, background, font size and style, graphics etc. while considering the design principles of an online lesson.

1.4 Implementation: Test the online learning instruction on a sample group of 31 students to find out whether it is efficient. The students use the learning tool for four lessons over four weeks after which they are tested. Next, collect the results from the experiment and carry out formative and summative assessments. Finally, based on the findings, improve the online instruction.

1.5 Evaluation: The online instruction is evaluated by three experts to verify its quality and provide comments. It is the improved according to the suggestions and tested for efficiency on the sample group of students. Next, it is adopted as a problem-based learning tool and used on a sample group of students whose knowledge is tested before and after using it.

2. Evaluate online instruction form in introduction programming to be rating scale 5 levels divide into content and produce media: Brought evaluate quality online instruction form in introduction programming to three experts for examine to improve. After that, the quality of the online instruction was evaluating by experts to find out the average and the standard deviation. Result of evaluation of content and production media is average is higher than 3.50. These will be considered the high-quality instruction found quality of online instruction of content in the average was 4.58 and the standard deviation was 0.62. These are in high level and quality of online instruction of produce media in the average was 4.67 and the standard deviation was 0.58. These are high level.

3. To test analytical thinking ability, the students answer 20 high-level multiple-choice questions with four optional answers. To find the index of item objective congruence (IOC), the validity is evaluated by experts. If the IOC value is higher than 0.05 it is considered a high-quality test. The validity test for analytical thinking skill was evaluated to find its IOC, and it was found that the value is higher than 0.67. Therefore, it reflects that the entire test has validity. Afterwards, 30 students, who are not in the sample group, and used to study in the subject of Introduction to Programming, took the test. The results from such testing were analyzed using statistics programs, and it shows that the difficulty/easiness index is between 0.50-0.60, which is in a fair level, for 20 items, and the discriminant (r) is in 0.27-0.47, which is in a good level, for 20 items, and the reliability is equal to 0.71.

Phrase II. Learning with a Sample Group

The 30 students in the sample group learned by using online instruction. The duration of the teaching and learning was 16 hours. The learning began with 1) explaining the learning objectives, then 2) the pre-testing of 20 items, followed by 3) conducting the instructional activities through online instruction for all of four lessons over four weeks and 4) a post-test of 20 items. The test results were statistically analyzed to find the average, the standard deviations and t-test dependency.

6. RESULTS

1) After formative and summative assessments, the efficiency of online instruction on the 31 students was found to be 80.16/80.32 which is in accordance with the efficiency criterion.

Table1. the results of the evaluation of the efficiency of the online instruction with problem-based learning in introduction programming to promote ability of analytical thinking.

Evaluating efficiency	Amount of sample group	Full score	Average Score (E_1/E_2)
Formative assessment	31	40	80.16
Summative assessment			80.32

2) The results show analytical thinking ability before and after learning using online instruction with problem-based learning in introduction to programming course. It was found that analytical thinking ability was higher after learning than before it, with a significant value of difference of 0.05

Table 2. The Results of Analytical Thinking Ability Tests Before and After using online instruction with problem-based learning in introduction programming to promote ability of analytical thinking.

Test	$\bar{x}$	S.D.	$\bar{D}$	S.D.$\bar{D}$	T	Sig.
Pre-test	9.57	3.58	5.07	2.73	10.17*	0.0000
Post-test	14.63	2.62				

*P < 0.05

7. DISCUSSION

1) After evaluating the efficiency of online instruction, the findings were 80.16/80.32 which is higher than the criterion of 80/80. The online instruction design consists of five steps based on the ADDIE model. These are as follows: 1) Analyze 2) Design 3) Develop 4) Implement and 5) Evaluate. The design was evaluated by six experts. The efficiency of the online instruction indicates that it can be used in teaching. This is consistent with the findings of Burisri [11] who conducted research on the development of web-based instruction, e-commerce systems and higher diplomas at the Department of Business and Computers, Narathiwat Technical College, and found that the web-based instruction in the e-commerce system had an efficiency criterion of

82.27/82.33, causing this researcher's study and analysis of the content to be further developed, objectives to be defined, the web-based instruction to be evaluated by experts and improved until it was ready for teaching students.

2). After comparing analytical thinking ability of the students before and after learning, the results show that the ability to think analytically was significantly higher afterwards than before learning, at a level of 0.05. The pre-test result was 9.57 and the post-test was 14.63, which relates to the hypothesis. This is consistent with the findings of Yappharas [12] who conducted research into the development of web-based instruction using problem-based learning to promote analytical thinking in Matthayom two (Grade eight). He found that analytical thinking ability was 7.73 pre-test and 17.80 post-test. Therefore, the students' ability to analyse a situation after the use of web-based instruction is higher than before its use, with a statistical significance of 0.05., causing problem-based learning is based on the problem determination process. This involves dealing with a problem seen in everyday life in order to motivate students. This incorporates such approaches as organizing group brainstorming sessions to encourage students to analyze problems, conducting self-study, exchanging learning, discussing the results of the study, and evaluating the work they are doing.

8. CONCLUSION

The research results indicate that online instruction associated with problem-based learning can help to promote analytical thinking ability in terms of introduction to programming through the development of systematic thinking. Students can synthesize and analyses programming in terms of a problem-based and problem-solving situation by using a strategy involving self-directed and collaborative learning. Throughout the process, the instructors are guided from the beginning to the end of the learning activity. A pilot study with online lessons was used as a teaching tool, and the indications were that the quality was good, and that the approach was suitable for the students. The researcher designed the online instruction based on the principles of the ADDIE model and the outcome was evaluated by experts and was subsequently improved. It has since been used in an actual teaching situation.

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