Social Science Asia, Volume 9 No 2, p:51 – 62 DOI :

UNPLUGGED CODING LEARNING MANAGEMENT FOR COMPUTATIONAL THINKING DEVELOPMENT OF PRATHOMSUKSA 6 STUDENTS

Sirawadee Romkaew [1] Saowaros Yingwanna[2] and Matee Di-sawat[3]

Abstract

This research and development aimed to 1) study current situations and needs for learning management to develop computational thinking of students, 2) develop a learning management model for development of computational thinking among Prathomsuksa 6 students and 3) study effects of using a learning management model for development of computational thinking among Prathomsuksa 6 students. The research was divided into 3 phases. Phase 1, the sample group was 175 teachers of science and technology learning subject group of schools under the Songkhla Primary Educational Service Area Office 3. Phase 2, the informants are 5 experts. Phase 3, the target group comprised 20 Prathomsuksa 6 students. The results showed that: 1) at present, teachers' overall conditions of learning management to develop computational thinking of students were at a moderate level and a high level of needs in learning management to develop students' computational thinking, 2) an unplugged coding learning management model for development of computational thinking of Prathomsuksa 6 students consisted of 8 components with a 4-step learning process, and 3) results of using the learning management model to develop computational thinking among Prathomsuksa 6 students found that the students' overall computational thinking ability was at a very good level.

Keywords: learning management, unplugged coding, computational thinking

Received: 15 August 2022, Revised: 29 August 2022, Accepted: 19 December 2022

[1] Graduate student, Master of Education Program in Research and Evaluation, Faculty of Education, Thaksin University. Email: sirawadee17@hotmail.com

[2] Lecturer, Ph.D., Department of Evaluation and Research, Faculty of Education, Thaksin University. Corresponding author, Email: saowaros@tsu.ac.th

[3] Lecturer, Ph.D., Department of Evaluation and Research, Faculty of Education, Thaksin University. Email: matee@tsu.ac.th

Introduction

Today's world is changing rapidly in every aspect of social, political, economic and technological advances. Education agencies need to improve their basic education curriculum while developing new skills that students need for the 21st century. Teachers should encourage and develop learners to have competencies and skills in reading, mathematics, advance thinking, innovation in science and technology, digital and foreign languages to increase competitiveness and choose to continuously study for future employment. Basic Education Core Curriculum 2008, revised in 2017, strand 4, Technology (Computing Science: CS), Standard Science CS 4.2 (Wor 4.2), focuses on enabling learners to understand and use computational concepts to solve problems found in real life in a step-by-step and systematic way and use information and communication technology to learn, work, and solve problems efficiently, knowingly and ethically. The Institute for the Promotion of Teaching Science and Technology (2017) defines computational thinking as computational thinking related to problem solving, systematic design, and understanding of how it works by using the basic conceptual framework of computer science, consisting of problem decomposition, pattern recognition, abstraction, and algorithm design that can be used to solve problems in other sciences or general problems in a systematic, logical and step-by-step manner. Therefore, computational thinking is indispensable for today's learners because students will face problems in the real world and must consider the problem, be able to manage information related to the problem, test the action plan, solve the problem to check errors and improve the operational plan. Although computational thinking ability is promoted in most computer science subjects, it is imperative that teachers should encourage their students in a variety of subject areas, not just computer science content. In accordance with the findings of Roungrong, Kaewurai, Namoungon, Changkwanyeun, & Tengkew (2018), it was found that computational thinking is a thinking process that requires skills and techniques to solve problems step by step and systematically. It is regarded as an important skill that learners need to develop because it is involved in enhancing other thinking skills. Office of the Education Council (2020) having discussed the current state of Thai education, found that most schools still use a lecture method for students to memorize and take multiple-choice exams, resulting in still having less analytical and synthetic thinking skills among students. Also, from teaching experience at the elementary level, the researcher realizes that the learners have trouble in analyzing the problem in a step-by-step and systematic way, including inability to solve problems in an applied way.

The learners are able to memorize the knowledge from the contents but lack the understanding of how to apply it to solve problems in other unconventional situations.

These are all elements of computational thinking, reflecting that the students still need development to analyze the problem in a step-by-step or systematic way to apply knowledge to solve problems in other ways. In addition, Songkhram, Klineam, & Supap (2020) state that in teaching and learning in mathematics subjects when students face situations of problem, most of them can only find out what the ending result is but they cannot clarify the problem-solving process. Moreover, when the students faced with similar

situations or problems, they are unable to apply the original problem-solving steps. In consistence, Na Ubol, & Chai-ngam (2022) reveal that when teachers set situations in the context close to everyday problems for elementary school students to solve, most of them solve the problem but cannot not explain the process of solving the problem because they are unable to analyze the elements of the problem as a result of their lack of computational thinking skills as well. Therefore, teaching and learning management should be in a format that enhances computational thinking ability by exposing the students to situations related to problem-solving. This is in line with the teaching and learning management of science in the 21st century in which teachers must provide science learning experiences that allow students to face problems and changes. This is a joint learning and development between students and teachers to encourage the students to have a learning process from real situations linked to the content in the lesson (The Institute for the Promotion of Teaching Science and Technology, 2017), strengthening learners with better ability to understand the lesson content easily and memorize for a longer time, including learning meaningfully and applying their knowledge in daily lives appropriately (Keereerat , 2019).

The study of learning management approaches for the development of computational thinking for elementary school students has revealed that there are various forms of learning management approaches for the development of computational thinking. One of the interesting approaches suitable for learning management at the elementary school level is learning management for unplugged coding. It is a learning management that focuses on learning to develop students' thinking on the basis that the classrooms and schools exist in a real context and a teaching and learning model that creates an understanding of the basic principles of computer science without the need of using computer. For these reasons, the researcher is interested in developing an unplugged coding learning management model to develop computational thinking ability of Prathomsuksa 6 students. It is appropriate to the local context of the school without the use of computers as a basis for solving problems, which can be applied to solve problems in everyday life.

Objectives

1. To study current situations and need for learning management to develop students' computational thinking skills.

2. To develop a learning management model for unplugged coding to develop computational thinking of Prathomsuksa 6 students.

3. To study effects of using an unplugged coding learning management model for the development of computational thinking of Prathomsuksa 6 students.

Conceptual framework for research

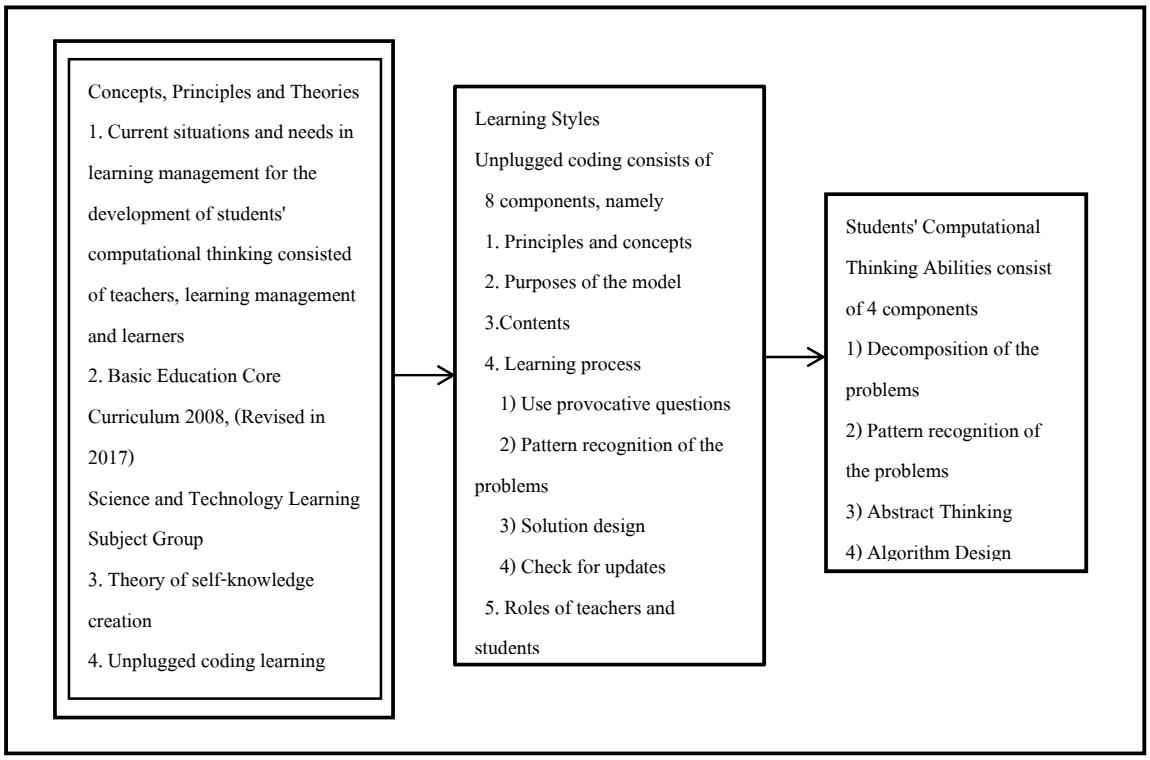

Figure 1 : Conceptual framework for research

Procedures

The research and development consisted of 3 phases as follows:

Phase 1: A study of current situations and learning management needs for the development of computational thinking skills of primary school students.

Population and sample

The population consisted of 309 teachers in science and technology learning subject group for the academic year 2021 of schools under the Office of Songkhla Primary Educational Service Area Office 3, Office of the Basic Education Commission, Ministry of Education.

The sample group consisted of 175 teachers in the science and technology learning subject group for the academic year 2021 of schools under the Songkhla Primary Educational Service Area Office 3. The researcher determined the size of the sample group by using the Taro Yamane formula and a simple random sampling method (Simple Random Sampling).

The content validity was between .80 and 1.00 and had a reliability value of .95. The questionnaire was divided into 3 parts as follows:

Part 1 : General Information of Respondents. The nature of the question is a check-list.

Part 2: Current situations and needs of learning management for the computational thinking development of primary school students consisted of the teacher's aspect, learning management and the learner's aspect. Question characteristics were Rating Scale The five levels are very high, high, moderate, low and very low.

Part 3: Additional comments, the nature of the question is an open-ended question.

Data collection

1. Contact the affiliation agency, namely, Songkhla Primary Educational Service Area Office 3, to prepare a request letter for data collection for research.

2. Data were collected from 175 teachers in the Science and Technology Learning Subject Group of schools under the Songkhla Primary Educational Service Area Office 3, using an online questionnaire using Google. Form through the management support system of Songkhla Primary Educational Service Area Office, Region 3.

Data analysis

Data were analyzed by mean and standard deviation of current situations and needs in learning management for the development of students' computational thinking of Prathomsuksa 6 students.

Data sources

Phase 2: The development of an unplugged coding learning management model for the development of computational thinking of Prathomsuksa 6 students. Five experts examined the quality of the unplugged coding learning management model for the development of computational thinking of Prathomsuksa 6 students. The researcher defined the qualifications of experts as follows: 1) Two of them were faculty members in institutions of higher education and the Office of the Basic Education Commission with doctoral degrees in curriculum and teaching, 2) Two educational personnel under the Office of the Basic Education Commission who specialize in developing computational thinking for elementary school students, and 3) Two of them were faculty members in institutions of higher education and the Office of the Basic Education Commission with doctoral degrees in fields related to educational research and evaluation.

Research tools

The Appropriateness Assessment of the Unplugged Coding Learning Management Model for the Development of Computational Thinking of Prathomsuksa 6 Students.

The researcher defined the components of the model from the theoretical concepts about the model, consisting of 1) principles, 2) objectives of the learning management model, 3) contents, 4) learning process, 5) roles of teachers and students, 6) response principles, 7) supportive systems, and 8) assessment and evaluation. The appropriateness assessment is a 5-point scale survey.

The appropriateness assessment of the learning management plan is divided into two parts: 1) an estimation scale for experts to consider the appropriateness of the learning management plan, and 2) an open-ended part for experts to make additional recommendations.

Procedures

The researcher developed an unplugged coding learning management model for the development of computational thinking of Prathomsuksa 6 students with the following details:

1. Analyzing the data obtained from the study of the current situations and the needs for learning management to develop students' computational thinking skills.

2. Drafting a learning management model by taking the theoretical concepts about model development and conclusions from Step 1 into consideration as a conceptual framework for learning management model construction and preparing a learning management plan.

3. 5 experts checked the quality of the learning management model and the learning management plan developed by the researcher.

4. A pilot experiment of the learning management model was tried to consider the feasibility of practice with 1 classroom of students.

The results of the pilot experiment revealed that a teaching and learning management model based on the learning possibilities was feasible for practical implementation.

Data analysis

The evaluation results of the learning management model and the learning management plan from experts were taken to find the mean and the standard deviation for comparison with the interpretation criteria.

Phase 3: The use of an unplugged coding learning management model was studied to develop computational thinking among Prathomsuksa 6 students.

Data sources

20 Prathomsuksa 6 students of Ban Samong School under Songkhla Primary Educational Service Area Office 3, academic year 2021, were selected by purposive sampling.

Research tools

The computational thinking competency test was created by the researcher by studying concepts, theories and research related to computational thinking. The learning management for developing computational thinking is a subjective test with 5 items. The content validity was between .80 and 1.00., and the improvement was revised according to the recommendations from experts as follows: 1) adjusting the situations to be suitable for the students, and 2) adjusting some questions to be a better clear version.

Data collection

The researcher clarified the students to understand the learning objectives and carry out the activities according to the five specified learning management plans. Then, after the learning management, the researcher tested the ability of computational thinking. The scoring criteria were classified according to the level of computational thinking ability. The scores were categorized into 4 levels: 4 points for very good, 3 points for good, 2 points for fair, and 1 point for improvement.

Data analysis

Quantitative data were analyzed by descriptive statistical analysis including frequency and percentage.

Research results

The researcher presents the results of an unplugged coding learning management model for the development of computational thinking of Prathomsuksa 6 students in 3 phases as follows:

Phase 1: Current conditions and needs in learning management for the development of computational thinking of primary school students.

Table 1 : Mean and Standard Deviation of Current Conditions and Learning Management and Needs for Developing Computational Thinking of Primary School Students

Aspects	Current Situations		Needs	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Teachers	3.34	0.58	4.28	0.67
Learning Management	3.36	0.57	4.44	0.59
Students	3.25	0.63	4.41	0.62
Overall	3.32	0.57	4.38	0.63

From Table 1, In the current situations, teachers had learning management to develop learners' computational thinking at a moderate level ($\bar{x}$ = 3.32, S.D. = 0.57). When considering each aspect, the teacher aspect was at a moderate level ($\bar{x}$ = 3.34, S.D. = 0.58), it was found that the learning management aspect was at a moderate level ($\bar{x}$ = 3.36, S.D. = 0.57), and the learner aspect was at a moderate level ($\bar{x}$ = 3.25, S.D. = 0.63). When considering the need for learning management to develop learners' computational thinking, it was found that teachers had the needs for learning management to develop overall learners' computational thinking at a high level ($\bar{x}$ = 4.38, S.D. = 0.63.) When considering each aspect, the teacher aspect was at a high level ($\bar{x}$ = 4.28, S.D. = 0.67), the learning management aspect was at a high level ($\bar{x}$ = 4.44, S.D. = 0.59), and the learner aspect was at a high level ($\bar{x}$ = 4.41, S.D. = 0.62).

Phase 2: The development of an unplugged coding learning management model for the development of computational thinking of Prathomsuksa 6 students.

1. The results of the development of an unplugged coding learning management model for the development of computational thinking of Prathomsuksa 6 students consisted of 8 components as follows: 1. Principles and concepts 2. Objectives of the learning management model 3. Contents 4. Learning process 5. Roles of teachers and students 6. Principle of response 7. Supportive system 8. Assessment and Evaluation. The learning process had 4 steps: 1. Using provocative questions. 2. Considering the form of the problems 3. Designing solutions and 4. Validation for improvement. The details were as follows: 1) Using stimulating

questions, starting from using important questions, creating situations for students to solve problems related to daily life, and train students to decompose the problems into smaller parts to make it easier to solve smaller problems, leading to solving big problems. 2) Considering the form of the problem. In this step, the students considered the relationship of the problems, compared groups, arranged the subsets of the problem, considered the decomposed of the problem, identify the key parts of the problems, distinguished the essential parts from the unimportant parts in order to obtain necessary and sufficient information for problem-solving, and used existing knowledge and experience to create a solution to find solutions. 3) Designing a solution. The students had the opportunity to design and create steps to solve problems. Each of them designed a different problem-solving solution based on their individual abilities and prior experience, and brought together in small groups a discussion on the solution to the problem from the situation given by the researcher. A clear sequence of work or solutions could be followed. 4) Checking for updates. The teachers and students evaluated together to identify possible solutions to problems and to detect errors and to improve solutions to achieve the goals.

2. The results of examining the unplugged coding learning management model and the developed learning management plan revealed that learning management styles and plans were appropriate at a high level.

3. The results of the pilot experiment to study the feasibility of practice with Prathomsuksa 6 students showed that the developed learning management process could be systematically implemented and teaching could be managed continuously.

Phase 3: The use of unplugged coding learning management model to develop computational thinking of Prathomsuksa 6 students.

A result of activities during learning management revealed that most students had the ability of computational thinking at the improvement level, representing 60.00 percent. When considering each aspect, it was found that 1) most students had the ability to decompose problems at the improvement level, representing 50.00 percent, 2) Most of the students had the ability to find patterns of problems at the improvement level, representing 65.00 percent, 3) Most of the students' ability in abstraction thinking was at the improvement level, representing 75.00 percent, and 4) Most of the students were able to design algorithms at the improvement level, representing 75.00 percent. And after completing the activities according to the unplugged coding learning management model to develop computational thinking, the researcher used a computational thinking capability test as shown in Table 2.

Table 2 : shows the number of students categorized by the level of computational thinking ability from the test.

Computational Thinking Ability	Number of students categorized by proficiency level (%)			
	Improved (1)	Fair (2)	Good (3)	Very Good (4)
1.Decomposing the problems	0 (0.00)	0 (0.00)	0 (0.00)	20 (100.00)
2. Recognizing patterns of the problem	0 (0.00)	0 (0.00)	6 (30.00)	14 (70.00)
3. Abstraction Thinking	0 (0.00)	0 (0.00)	13 (65.00)	7 (35.00)
4. Algorithm designing	0 (0.00)	0 (0.00)	17 (85.00)	3 (15.00)
Overall computational thinking ability	0 (0.00)	0 (0.00)	5 (25.00)	15 (75.00)

From Table 2, most of the students had computational thinking ability at a very good level, representing 75.00 percent. When considering each aspect, it was found that 1) the students had the ability to decompose problems at a very good level, representing 100.00 percent, 2) Most of the students had the ability to find patterns of problems at a very good level, representing 70.00 percent, 3) Most of the students had good abstraction thinking ability, representing 65.00%, and 4) The students' ability in designing algorithms was at a good level, representing 85.00 percent.

Discussion

The researchers discussed the results according to the research objectives as follows:

1. The learning management model for developing computational thinking of Prathomsuksa 6 students consisted of 8 components as follows: 1. principles and concepts 2. objectives of the learning management model 3. contents 4. learning process 5. roles of teachers and students 6. principles of responses 7. supportive system 8. assessment and evaluation. There are 4 steps in the learning process: 1. using provocative questions. 2. considering the patterns of the problems 3. designing solutions and 4. checking for improvement. The development of this learning management model is in line with the concept of Pengsawat (2010) which proposed that determining the components of the model, what and how many components to include, how many structures and how they are related, depending on the phenomena, factors or variables being studied. Designs were mainly based on concepts, theories, research, and basic principles in determining the model. The model development was divided into 2 steps: 1) model creation or development, and 2) model validity. The learning activities developed by the researcher was in accordance with the concepts of Wechayaluck (2018), which proposed guidelines for designing learning activities for learners that the instructor had to focus on the learner's roles in learning by participating enthusiastically in learning and using thinking process skills together with the pursuit of knowledge in order to maximize the benefits for the learners. Similarly, Kowtrakul (2016) stated that teaching thinking in schools required teachers to use questions to encourage the students to use their thinking to compare or find relationships between objects. As well as, the findings of Ainthapanya, & Hiengraj (2011) found that students can solve a variety of problems similar to the original situation will help them to apply to solve real problems in everyday life and help them practice skills to achieve true understanding,

by giving students the opportunity to practice thinking individually to develop the thinking of the learners. In addition, the practice of thinking in small groups was an opportunity for the learners to practice thinking in groups because different opinions caused conflicts of mind. This would encourage the learners to make a try to find information to adjust their thinking.

2. The results of the development of computational thinking abilities of Prathomsuksa 6 students during and after the learning activities were organized by using the unplugged coding learning management model. When considering each component of computational thinking from activity sheets and the computational thinking ability scale, it was found that the trend of computational thinking ability increased in each lesson plan and after using the management model. Students' overall computational thinking abilities were at a very good level. Obviously, the unplugged coding learning model helped develop computational thinking ability and could develop the following subcomponents of computational thinking as follows:

2.1 The students developed their overall ability to decompose the problems at a very good level. As a result of the unplugged coding learning activity, the students analyzed the problem situation and decomposed it into smaller parts for easy problem-solving, starting from the learning management process in step 1, using provocative questions. This step introduced students to the problem by starting with the key questions and the situation created for solving problems related to everyday life. The students were trained to decompose a problem into smaller parts so as to to solve the decomposed problem easier, leading to bigger solutions. Problem decomposition should be the first competency that students should develop. According to Keereerat (2019), computational thinking is a learning ability and a thinking process that involves problem solving. It starts with understanding a complex problem by defining the scope of the problem and then analyzing the problem into smaller parts. The development of computational thinking can be done by learning management and integrating problem situations, which results in the development of effective computational thinking. In addition, in step 1, using stimulating questions, a variety of media were used in teaching and learning management to stimulate students' interest. In line with Saleewong, Imsiri, & Thongtawee (2018), the use of media in managing a variety of teaching methods will stimulate students' learning interest and make learning and teaching achieve the set objectives.

2.2 The students developed their ability to recognize overall patterns of problems at a very good level. The students could recognize the patterns of the problems from step 2, recognizing the patterns of the problems. In this step, the students considered relationships, comparing, grouping, arranging, and decomposing the problems. In accordance with Siriphan, & Srisawat (2011), the teachers had to let the students study the problems first and then assigned them to seek additional knowledge for solutions This allowed the students to practice thinking and solving problems and helped develop them to be familiar with continuous research, information, knowledge from various sources and knowledge requiring the ability to decompose and analyze data together with a summary of the obtained information to derive issues and essence.

2.3 The students developed their overall abstraction thinking ability at a good level. From step 2, the students could develop their ability of abstraction

thinking, recognize the problem's patterns by considering the decomposed parts of problem in detail, identify the key parts of the problem, distinguish the essence from the non-trivial ones in order to obtain the necessary and sufficient information to solve the problem. The students could logically state the essence of a problem by learning, gathering data, doing activities on their own and discussing with peers, consistent with Loapideht, & Sirismphan (2013), stating that the teachers should allow their students to find problems on their own, and evaluate solutions to select the best approach in solving problems and encouraged the students to act, resulting in the development of the ability to focus on the learner-center method with the advice of the teacher and the situation as a stimulant to motivate learning. Also, in accordance with Yenya, & Prasertsin (2019), they said that teaching and learning should focus on students' participation and interaction with the contents and the lessons, emphasizing that the students took action in seeking and creating knowledge by themselves. The teachers only provided advice and suggestions for their students.

2.4 The students developed their overall algorithm design ability at a good level. From step 3, students could develop their algorithmic design abilities. The students had the opportunity to create a problem-solving process whereby each of them designed a different problem-solving approach based on their individual abilities and prior experiences and discussed the solution in small groups gained from the situation that the researcher determined to show the order of work or clear problem solving that could be followed. It was in accordance with Roungrong et al. (2018), revealing that the thinking process requires skills and techniques to solve problems. The sequence of steps and solutions must be presented in a way that the problem solver could effectively follow. And the algorithm design was checked in step 4, checking for improvement. The students and teachers shared assessments to identify possible solutions to problems, be able to detect errors and improve solutions to achieve the goals.

Suggestions

Suggestions for application

According to the research results, Unplugged Coding Learning Management Model can improve students' computational thinking ability. Therefore, when implementing the learning management model, teachers should understand and act according to the components of the learning model. The situation used in learning management should be close to the students.

Suggestions for further research

To study and research on the development of learning management model, those interested can improve or extend the process of learning activities to fit the context of the school and the basic characteristics of the students to create knowledge and develop students' computational thinking abilities.

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