Development of Learning Computational Thinking Management Model Using Phenomenon-based Learning with the Aid of Infographics to Enhance Computational Thinking Skills of the Eighth Grade High School Students

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Abstract

The purposes of this research were; 1) to build and find efficiency of learning management model to be effective according to the 80/80 standard. 2) to study the result using Learning Management Model and 3) to study the students' satisfaction with learning management model. The research processes were consisted of 4 phases as follows; 1) the study of basic data, 2) the design and development of learning management model, 3) conducting an experiment, and 4) administering an evaluation. The research sample consisted of 40 students who were studying in the eighth grade high school students at Chiang Rai Municipality School 5 Denha during the 1st Semester in 2021 by Cluster Random Sampling method. Research instruments were included of documentary analysis forms, interview forms, teaching plan, learning management model, computational thinking skills test, and satisfaction questionnaire of learning management model. The data were analyzed by using percentage, mean, standard deviation (S.D.) and the statistical test (Dependent sample t-test). The results showed that; 1) Learning Computational Thinking Management Model Using Phenomenon-based Learning with the Aid of Infographics to Enhance Computational Thinking Skills of the Eighth Grade High School Students was called '3SE Model' had got the efficiency value of E1/E2 were equal to 83.00/83.06 and satisfied the criteria 80/80 2) The posttest scores of Computational Thinking Skills test

higher than the specified 70% threshold statistically significance at the .01 level with overall average was equal 83.00 percent 3) Students who studied with Learning Management Model had overall satisfaction at the highest level ($\bar{X}$=4.58, S.D.=0.51).

Keywords: Learning Management Model, Computational Thinking Skills, Using Phenomenon-based Learning, Infographic.

Introduction

The technological advances are rapidly developing. It results in educational reforms according to the direction and strategic framework of the 12th National Economic and Social Development Plan (2017-2021). It is prepared on the basis of the 20-year National Strategy Framework (2017-2036), which is the main plan of national development and sustainable Development Goals (SDGs), the National Education Plan 2017-2036, including the country's restructuring towards Thailand 4.0, which is a national strategy that will be used as a framework for development in the 20 years phase. The vision and direction of the country's development towards "security, prosperity, and sustainability" for the country's development reflects on the philosophy of sufficiency economy. The national development plan was implemented with the aim to achieve better results following the development strategy of the country as well as to enhance people's skills to be prepared for the task ahead. It focused on raising the quality of the country's population by developing people to suit their age and to grow with quality. Developing skills that accords with the demand of the labor market and the skills necessary for life in the 21 st century (Office of the National Economic and Social Development Council, 2016, Office of the Education Council, 2017, Office of the Basic Education Commission, 2017)

In the 21st century's education, teachers need to adjust teaching approach and search for new knowledge to teach learners with the 21st-century. The 21st century learners to be ready for lifelong learning with adaptability in order to start the change within them. It can be seen that critical thinking and problem-solving are one of the learning skills in the 21st century. Basic Education Curriculum Revised edition of the year 2017, Stand 4, Standard 4.2, focuses on learners to understand and use computational concepts to solve problems encountered in real life systematically and step by step. Use information and communication technology in learning to work and solve problems

effectively, to be knowledgeable, and ethical. Computational thinking skills is a systematic problem-solving skill that consists of critical thinking, problem-solving, problem identification, problem-solving, creativity, and intellectual knowledge. This is the basis for solving complex problems in an easy way and it is the basis of the writing program. Preparing citizens for the 21st including promoting basic skills for everyone, not just for computer engineers or technicians, it is the basis for creating innovations in response to Thailand's 4.0 policies. However, elements of computational thinking, such as dividing a large problem into problems/sub-tasks (decomposition), considering the pattern of the problem or the solution (pattern recognition) considering the essence of the problem (abstraction), and algorithm design can apply computational thinking in solving a variety of problems in daily life (Khuana. K & Khuana. T, 2019).

Phenomenon-Based Learning Management is a newly developed concept to support the development of technology and the world changing in the 21st century with various information and media, it requires recipients to use the ability to think critically or make decisions that are suitable to reality. In addition, it was found that the results of Finland's PISA assessment which were among the top in the world, accorded with Finland's learning management that took the educational innovation to use (Zhukov, 2015). The researcher has chosen the concept of learning management using a phenomena-based for learning approach to develop the computational thinking skills of target students. It is consistent with the development of the ability for critical thinking and the ability to solve problems, which is one of the important skills of learners in the 21st century. Educational institutions at all levels must instill in learners as the research by Mahawijit (2019) that has applied the concept of phenomenon-based learning. This is a concept of learning management in a multidisciplinary constructivist group that uses the survey learning approach with problem-based by proactive learning in the learning activities designed in elementary school to enhance learning skills in the 21st century. Another technique that will help students summarize complex content easily is infographics with phenomena-based to organize the learning approach to help develop computational thinking skills as well. At present, the infographic is interesting media in teaching and learning methods. Infographic is used to present and summarize information, it is a suitable tool to explain information to make it easier to understand, faster and clearer format (Karnsomjai, 2016). It makes the content easier and interesting

(Lekchinda, Suksamkaew, Kwangsawa & Saikatikorn, 2018) and helps to create awareness, quickly and easily to understand the content.

Accordingly, the researcher has recognized the problem and importance of learning about computational concepts that it is important for education nowadays. Therefore, the learning computational thinking management model has been developed using phenomena-based learning with the aid of infographics to enhance computational thinking skills of the Eighth Grade High School Students, which will enable students to have higher computational thinking skills, learn happily, study lessons that are suitable to their needs, receive variety of learning activities and adapt to the new trend, thus making the students the focus of this course, receiving all these benefits.

Research Objectives

1. To build and find efficiency of learning computational thinking management model using phenomenon-based learning with the aid of infographics to enhance computational thinking skills of the eighth grade high school students following the 80/80 effective criteria.

2. To study the result using of learning computational thinking management model using phenomenon-based learning with the aid of infographics to enhance computational thinking skills of the eighth grade high school students.

3. To study the students' satisfaction with learning computational thinking management model using phenomena-based learning with the aid of infographics to enhance computational thinking skills of the eighth grade high school students.

Literature Review

Phenomenon-based Learning Management Concept

The learning using phenomena-based approach is increasingly popular in teaching and learning management. This is a multidisciplinary learning that was proposed in Finland based on the idea of developing the country's education core curriculum. To support the development of transversal competencies of learners to be ready for real life, which learning management will bring phenomena or situations that are interesting issues to make learners curious, make questions, and embark on an answer

through the learning process according to the concept of self-knowledge theory under authentic phenomena (Sahlberg, 2021).

The phenomenon-based learning approach will start with observing the phenomena that are taking place in the real world and followed by the learners asking questions. It consists of 5 dimensions (Mattila & Silander, 2015) these are:

1. Holisticity, refers to an integrated learning which uses cross-disciplinary knowledge to naturally focus on issues of interest. It has an interdisciplinary model that emphasizes and enables learners to understand situations and events that occur according to real conditions without dividing subjects' content similar to the general learning approach.

2. Contextuality, refers to applying the learning in solving problems or create interests related to the daily life of the learners and the community to make learning meaningful. The phenomena used can be predetermined, but unclear points or information, in order to encourage students to observe and analyze through a learning approach.

3. Authenticity, refers to using real-world situations to drive activities for learners to acquire knowledge about community culture. Learning concepts and theories from local experts and understanding community solutions from local philosophers by the learners are the creators of their own knowledge through the practice with real expertise and experience.

4. Problem-based inquiry learning, it begins with learners identifying problems, then asking questions from different situations they faced to help learners achieve their goals. By practicing solving problems, analyzing the problem, and solving it, learners will be curious, will develop critical thinking skills, and problem-solving skills.

5. Learning process involves the process of developing hypotheses and building a theory, learners can plan the learning approach by themselves. The learning approach must be related to problem-solving. Learning is connected with real situations or phenomena; it can adjust the answers searching according to the situation at any time. Teaching is student-centered, with teachers encouraging, supporting, and facilitating learners so that they can design learning guides to find answers.

The process of learning approach using phenomena-based (Daehler & Folsom, 2016) are as follows:

1. Choose an interesting phenomenon. The teacher selects an interesting phenomenon according to the content and the learner's level. The chosen phenomenon may be fully or partially explained from the learner's experience and it should be a set of the phenomenon, as each lesson does not use a single completed phenomenon.

2. Analyze the usefulness of the lesson. Learners analyze themselves what knowledge they will gain from learning and how to apply the knowledge about related phenomena in other contexts. Teachers can manage learning approaches with teaching techniques such as lectures, teaching materials, meeting with experts, etc. To encourage learners to understand the phenomenon that cannot organize teaching activities, it is not necessary to study in the classroom.

3. Conducting studies research. Learners participate in planning activities, defining steps and methods for finding answers. Conducting individual and group research studies with a variety of methods, observing the phenomenon, giving the opportunity for students to discuss and ask questions in order to find answers. Teachers support and stimulate learners by using questions such as “What issues do you want to learn from the observed phenomena?” This encourages learners to take part in doing activities related to the observed phenomena and to plan learning activities, then set methods for finding answers to gain new knowledge and lead to conclusions.

4. Synthesize knowledge and conclusion. Learners apply the knowledge that they have researched to exchange, discuss the results, and synthesize the knowledge they have acquired to acquire new knowledge leading to the conclusion.

5. Check learners' understanding through explanations. Teachers assess learners based on actual conditions through oral presentations. Writing a description to reflect the understanding of scientific concepts that correspond to phenomena to the learners can lead to finding answers and finding information from learning activities and applying them to explain the phenomena in real life.

Evaluation of the learning approach using phenomena-based should be divided into performance, content, and application to have the same weight of the score. To enable learners to see the importance and consistency in applying content and competencies in real-situation by evaluating the learning approach using phenomena-

based, by assessing according to the actual situations and may evaluate every step of the learning approach.

Conceptual Framework

To achieve the aims of this research, the researcher has set the conceptual framework as shown in Figure 1.

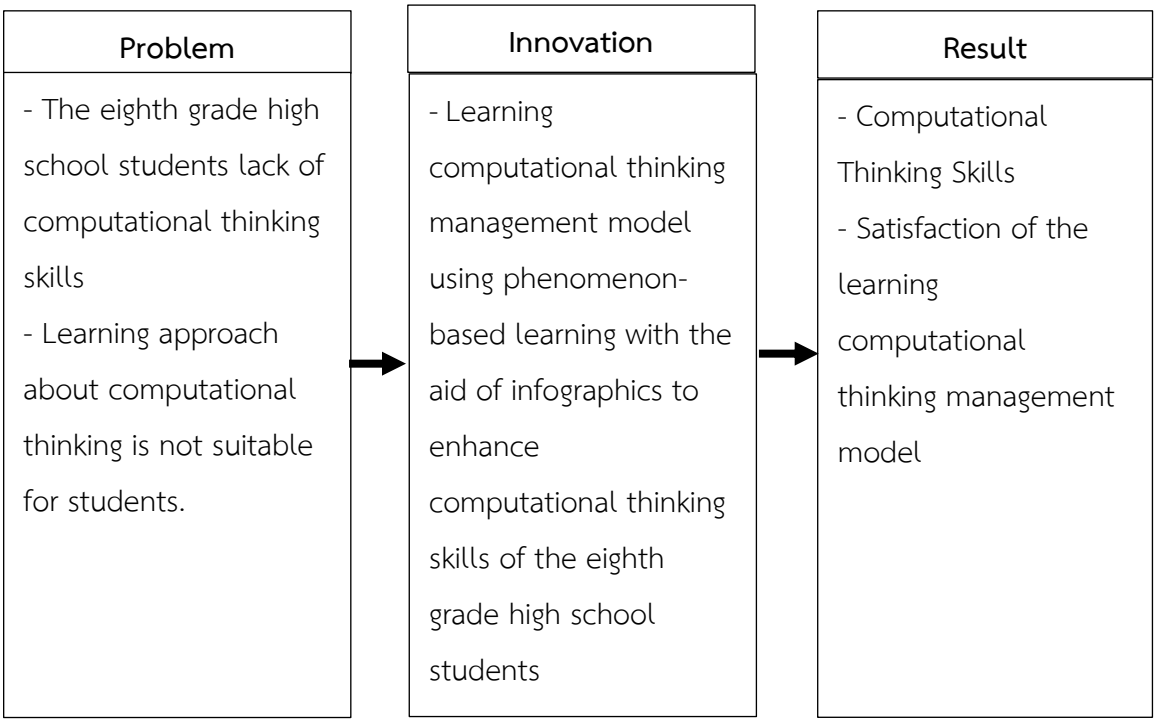

Figure 1: conceptual framework

Research Methods

This is a research and development that is divided into 4 steps:

Step 1: Research (Research: R1) The purposes is to study the basic information and the needs of administrators and teachers of computational thinking subject in the eighth grade high school students at Chiang Rai Municipality School 5 Denha in 1st semester, the academic year 2020, for 3 teachers. The Methods are as follows: 1) Analyzing basic information on educational policy and the National education plan, 2) analysis of the Basic Education Core Curriculum of 2008 and the learning standards and indicators of Science and Technology (Updated Edition 2017), 3) analyzing the teaching and learning

management in computational thinking in the Eighth Grade High School Students, 4) to study the concepts, theories and research related to the developing of learning computational thinking management model using phenomenon-based learning with the aid of infographics to enhance computational thinking skills of the eighth Grade High School Students, and 5) to ask administrators and computational teachers about the need to develop a learning management model to promote computational thinking skills.

Step 2: Development (Development: D1) The purposes are to design and develop the learning management model. The Methods are as follows: 1) Design and develop tools used in learning management, such as learning plans and learning management models, 2) design and develop the gathered data tools, such as a computational thinking skill test and students' satisfaction questionnaire on learning management, 3) to take the tools developed for experts to check and take the information obtained to improve the tools, and 4) To take the tools developed was applied to experiment with the eighth grade high school students in 1st semester, the academic Year 2020.

Step 3: Research (Research: R2) 1) To find the effectiveness of the developed learning management model, 2) to study the effect of using the developed learning management model called 3SE Model, and 3) to study the students' satisfaction with the learning management as well learning management model. The sample group is room 4 of the eighth grade high school of Chiang Rai Municipality School 5 Denha in 1st semester, the academic year 2021, a total of 40 students, which were obtained by Cluster Random Sampling. The methods are as follows: 1) take the developed teaching and learning model was applied with a sample group of students, 2) study the effectiveness of the learning management model, 3) study the computational thinking skills, 4) compare the results of the computational thinking skills assessment of students after school (post-test) with the 70% criteria, and 5) study the students' satisfaction with learning with the learning management model. Data were analyzed by using percentage, mean, standard deviation, test statistics, t-value, and presented the data analysis results using tables and lectures.

Step 4: Development (Development: D2) The purposes are to evaluate the developed learning management model, then use the assessment results to improve and modify them to be the completed learning management. The methods are as follows: 1) ask for the opinions of teachers in computational science and other teachers towards the model of learning management developed, and 2) use the information obtained to improve the learning management model to be accurate and complete. Data were analyzed by using percentage, mean, standard deviation and presenting the data analysis by using tables and lectures.

Research Results

1. The results of build and find the efficiency of the Learning Computational Thinking Management Model through Phenomenon-based Learning Approach with the aid of Infographics to Enhance Computational Thinking Skills of the Eighth Grade High School Students according to the 80/80 criteria.

1.1 The developed learning management model called the 3 SE Model, consists of 6 steps of learning management, which is: Step 1, giving examples of situations and phenomena that occur according to actual conditions (Sample: S). Step 2: Expand learning boundaries (Explanation: E). Step 3: Choose a problem situation to be studied (Selection: S). Step 4: Learning from the actual problem situation (Execution: E). Step 5: Exchange learning (Share: S). Step 6: Evaluate the learning outcomes (Evaluation: E)

1.2 The efficiency of the Learning Management Model '3SE Model' are shown in Table 1.

Table 1 the results of creating and determining the efficiency of the learning management model.

Efficiency	Number of Student	Score	Average score	Percentage	Meaning
During class/Process (E_1)	40	120	99.60	83.00	Higher
After class/Result (E_2)	40	40	33.23	83.06	Higher
E_1/E_2 = 83.00/83.06					

From Table 1, it was found that the Learning Computational Thinking Management Model through Phenomenon-based Learning Approach with the aid of Infographics to Enhance Computational Thinking Skills of the eighth grade high school students had the efficiency of 83.00 and the resultant efficiency was 83.06, which was higher than the set efficiency criterion of 80/80.

2. The results of using the Learning Computational Thinking Management Model through Phenomenon-based Learning Approach with the aid of Infographics to Enhance Computational Thinking Skills of the Eighth Grade High School Students.

2.1 Comparative results of the students' computational thinking skills measurement results after learning with the learning style with the specified 70% criteria. The results are shown in Table 2.

Table 2 shows comparative results of the students' computational thinking skills measurement results after learning with the learning style with the specified 70% criteria.

Grade	Number of Student	Average	Standard Deviation	t
After studying	40	33.23	1.51	21.88**
70 criteria percentage	40	28.00		

**Statistically significant at .01 level

From Table 2, it was found that the results of the computational thinking skills measurement after studying with the learning computational thinking management model using phenomenon-based learning with the aid of Infographics, the threshold was higher than the required 70% with statistical significance at the .01 level.

2.2 The results of promoting computational thinking skills with a developed learning management model

Table 3 shows the results of the promotion of computational thinking skills with a developed learning management model.

Computational Thinking Skills	$\overline{X}$	S.D.	Percentage
Component 1: Decomposition	25.63	1.10	85.42
Component 2: Pattern Recognition	24.60	1.68	82.00
Component 3: Abstraction	25.10	1.08	83.67
Component 4: Algorithm	24.28	1.15	80.92
Overall Average	**24.90**	**1.37**	**83.00**

From Table 3, shows that using the learning computational thinking management model using phenomenon-based learning with the aid of Infographics, had computational thinking skills' overall average was 24.90, the standard deviation was 1.37. The percentage was 83.00. When considered in each aspect, it was found that the big problem was divided into sub-problems and had the highest average skill development was 85.42% ($\overline{X}$ =25.63, S.D.=1.10) and algorithm design had the minimal skill development was 80.92% ($\overline{X}$ =24.28, S.D.= 1.15).

3. The results of the study of student satisfaction with the Learning Computational Thinking Management Model through Phenomenon-based Learning Approach with the aid of Infographics to Enhance Computational Thinking Skills of the Eighth Grade High School Students.

Table 4 The results of the study of the students' satisfaction with learning with the learning management model '3SE Model'.

Assessment	$\overline{X}$	S.D.	Meaning
Learning management model	4.54	0.52	Highest
The surroundings of the learning management model	4.55	0.51	Highest
The benefits of the learning management model	4.63	0.50	Highest
Overall average	**4.58**	**0.51**	**Highest**

From Table 4 , it was found that the overall satisfaction of students with the learning management model '3SE Model' was at the highest mean ($\overline{X}$ = 4.58, S.D. = 0.51).

The study of student satisfaction with the learning computational thinking management model using phenomenon-based learning with the aid of Infographics got the highest average overall students' satisfaction ($\overline{X}$ = 4.58, S.D. = 0.51).

Conclusions and Discussion

The results of developing of learning computational thinking management model Using phenomenon-based learning with the aid of infographics to enhance computational thinking skills of the eighth-grade high school students summarize as follows.

1. The developed phenomenon-based learning management model with infographics was known as the 3SE Model, it consists of 6 steps as follows: Step 1 sample of situations and phenomena that occur according to reality (Sample: S). Step 2 expands the scope of learning (Explanation: E). Step 3 select a problem situation to be studied (Selection: S). Step 4 execute learning from the real problem situation (Execution: E). Step 5 sharing the knowledge (Share: S). Step 6 evaluates the learning results (Evaluation: E). The learning management model has been developed with efficiency values of 83.00/83.06, which is higher than the set efficiency threshold of 80/80.

2. The results of the computational thinking skills measurement after studying with the developed model, the eighth grade high school students had computational thinking skills higher than the required 70 percent with statistical significance at the .01 level.

3. The result of promoting computational thinking skills with a developed learning management model, the eighth-grade high school students had computational thinking skills of 83 percent.

4. The satisfaction of the eighth-grade high school students towards the developed learning management model to promote computational thinking skills overall was at the highest level.

Research Discussion

The researcher discusses the results of developing of learning computational thinking management model using a phenomenon-based learning with the aid of infographics to enhance computational thinking skills of the eighth-grade high school students as follows:

1. The effectiveness of a phenomenon-based learning management model in combination with developed infographics, which is called the 3SE Model, is equal to 83.00/83.06. It equals the performance criteria set 80/80, consistent with the first research hypothesis, as a result of 1.1) the developed learning management model was developed systematically in the correct process. Analysis of the basic information about education policy, National Education Plan, and The Basic Education Core Curriculum be 2551 of Science and Technology in the 4th learning standard technology of the eighth-grade high school students. The administrators and teachers of computational science were asked about the need to develop a learning management model. To promote computational thinking skills and take the created learning model to 5 experts for validation by checking the quality of integrity in content based on the determination of Index of Conformity (IOC), which had a value of 1.00 for all items. A revised learning management model was adopted as recommended by experts to find the efficiency of E1/E2, the researcher conducted 2 experiments, which are small group tryout and field tryout. Then, the improved learning management model was verified for suitability and completeness before experimenting with the sample group. As Joyce & Weil (1996) said, in creating and developing a learning management model, the creator must study the concepts and key elements involved in teaching, define the element and the relationship of the element form, check the model's performance and improve learning management 1.2) computational learning activities using the developed model to emphasize students to do practical work in solving problems and finding answers on themselves, that was the nature of teaching and learning activities in each activity, students will study from examples in real situations and they can talk and exchange knowledge with their classmates and teachers at all times. The teacher will motivate, facilitate, ask questions and arrange situations to suit students' background knowledge. To encourage students to think and connect knowledge until learning is meaningfully stored in long-term memory (Karin, 2019).

2. The results of using the developed learning management model to promote the computational thinking skills of the eighth-grade high school students are higher than the specified threshold of 70 percent after studying, and it is consistent with the second research hypothesis. It reflects that the students learned better because of phenomenon-based learning with infographics, it is a model of learning approach that focuses on integrating knowledge through real phenomena in which students learn computational thinking skills through real practice. It is consistent with Butktanyu (2018) who said that learners should have appropriate skills and learning styles to find answers to a variety of problems with no limits. In addition, the model of learning approach that has been developed is blended learning between phenomena as a base with infographics that can promote the students' computational thinking as well. This is consistent with the research of Sueaprae et al. (2016), which found that the learners who studied with blended learning had a high level of satisfaction. Students were able to score statistically significantly higher than their .01 score for computational skills after studying.

3. The satisfaction of the eighth-grade high school students towered the developed learning management model to promote computational thinking skills. Overall was at the highest level, consistent with the third research hypothesis, possibly due to the developed learning management model. Students summarized complex content in an easy-to-understand way, using the infographics in organizing learning activities with phenomena-based to help develop computational thinking skills as well because infographics were interesting and easier to understand the content. This is consistent with the research of Lekchinda et al. (2018) found that the use of infographic media affects perception, quickly understanding the content, and it's easier than recognizing it from letters. And research by Karnsomjai (2016) found that infographics can greatly enhance the creativity of high school students.

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