

STEM Education Activities Development to Promote Computational Thinking's Students

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Abstract— This research aims to develop STEM learning activities for promote student's computational thinking skills and the results of this learning activities toward computational thinking of senior school student in the computing classroom. The study groups were 30 secondary school students in Pranakorn Si Ayutthaya who were studying in Semester 1, Academic Year 2019. They were selected by purposive sampling method. The research instruments were; (1) STEM education lesson plans for computational thinking developments; (2) The student's journals; and (3) Computational thinking test. The research was divided into three phases. The first phase focused on design lesson plans and learning activities for developing student's computational thinking skills. The second phase is implement the lesson plans and learning activities with the study group. The third phase is evaluation of the effectiveness of learning activities on develop student's computational thinking skills. The results shown learning activities can develop student's computational thinking skills, because of these activities were challenged students with real everyday life problems that required to used their computational thinking to solve the problems by decompose problems, find pattern recognition, abstraction thinking and develop algorithm for computer programming. So, these STEM learning activities could be effectively used in Computing course.

Keywords— Computational thinking, STEM Education.

I. INTRODUCTION

For economic and social development to progress, it is necessary to increase the potential of citizen. So, we need enhance the quality of education in science, mathematics and technology at all educational levels. Especially, computational thinking, a problem-solving process to find logically and systematically answer. It helps consider how to use and what information is required, how are each data related to each other. Identify what information is essential to problem-solving [1, 2] which are essential to live amid the rapidly changing in 21st century and big data from the internet [3]. So, computational thinking is a thinking skill that every Thai youth needs to be developed to live in the 21st century with quality and competitiveness in both economic and social aspects. One of the guidelines for the development of computational thinking is to organize learning activities according to the STEM education approach by allowing students to write computer programs [3, 4]. Then, studying the effect of learning management

through learning activities according to STEM Education to promote computational thinking of the students. The researcher has developed lesson plans and learning activities by a 5E instructional model combined with engineering design or the 5E2DO learning model [5], a learning model that combines the 5 features of science inquiry and core idea of engineering design. For learning activities will focus on develop computer programs based on the knowledge of science, mathematics and engineering design process to obtain a product or process for solving problems in real life as show in Figure 1.

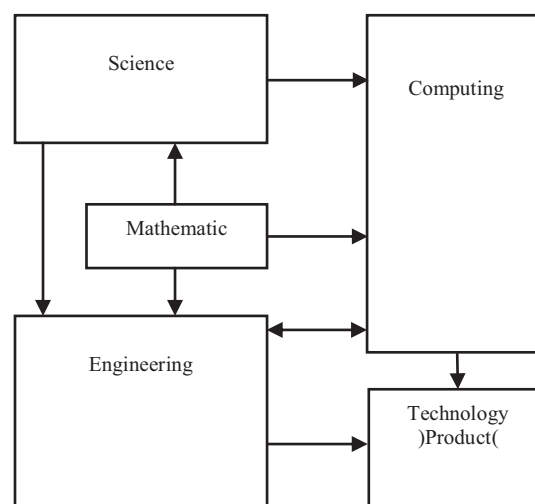


Fig 1. Concept of learning activities according to STEM education to develop computational thinking.

The results from this study will lead to the development of learning activities according to the STEM education approach for learning management in the Science subject, Technology Standard V 4.2 according to the B.E. 2551 (A.C. 2008) and revised in B.E. 2560 (A.C. 2017) to be effective.

II. OBJECTIVE

1. To study and develop learning activities according to STEM guiding principles for develop students' computational thinking.
2. To study the effect of learning activities according to computational thinking skills of senior high school students.

III. METHODOLOGY

This research is a mixed-research method. A qualitative research method was explained the quantitative research results.

A. Study Group

The study group was senior high school students in Phranakhon Si Ayutthaya province, 30 students who studied computing courses in the first semester of the academic year 2019, sampling by purposive sampling method.

B. Research Tool

- Lesson plans and learning activities according to STEM Education guidelines. There are 6 lesson plans and learning activities, Scratch programming, Persistence and animation, Visakhabucha Day, Python programming, coordinates and Robot Builder. These lesson plans and learning activities were examined by 5 experts. The consistency coefficient (IOC) value is between 0.60 - 1.00.
- Computational thinking test. The researcher developed a computational thinking test based on the Brebas Thailand approach [6], Faculty of Information Technology. King Mongkut's Institute of Technology Ladkrabang, 20 items that were examined by 5 experts, It had the difficulty index (P) between 0.20 - 0.80 and the discriminant power index (r) from 0.20 and above.
- Research period. Semester 1, Academic Year 2019, total 12 weeks, 2 periods per week.

IV. RESULT

For examining research hypothesis that STEM learning activities can develop computational thinking skill's students. The data was gathering before and after participating in the learning activities. Then data were analyzed by statistical t-test dependent sample, at $p < 0.05$ as shown in Table I.

TABLE I Comparing computational thinking average score before and after participating in learning activities.

Score	n	\bar{x}	S.D.	d.f.	t	p
Before	30	15.0	7.02	29	7.31*	0.00
After	30	18.0	2.02			

* At $p < 0.05$

From Table I, the mean score of computational thinking skills of students after participating in the learning activity was significantly higher than before participating in the learning activity at the level 0.05. (full score is 20) according to hypothesis that STEM learning activities can develop computational thinking skill of students. Another, the researcher reads the data that the students wrote about what they learned in the weekly journal and activity sheet about 12 weeks for

content analysis. The analysis criteria are 4 key elements of computational thinking skills: problem decomposition, pattern recognition, abstraction and algorithm to solve problems. It was found students had a better improvement after participating in the learning activities as follows.

a) Decomposition, when the learner has done learning activities on The story of Visakha Bucha Day. Students have knowledge, understanding and can decompose problems. The students use Scratch program to create scenes such as birthplace, enlightenment, nirvana, and write a script for each character (sprite) to talk about this story. A student recorded in her journal.

"... Scratch is a language program that can be easily used to create animation such as fairy tales that can interact with readers. It allows students to decompose problem, learn mathematical principles and program-ming concepts while thinking creatively, reasoning, system thinking and collaborative..."

b) Pattern recognition, when the learner has done a learning activity on Robot Builder, which is computer programming to create animation by Python language. The researcher found that the students did not have much knowledge and understanding about the patterns. Because students are focus on the typing and syntax of Python program that complex more than a scratch program. A student wrote in the journal.

"... It is very sensitive to write Python, making it difficult to write Python. Because of every command used in writing is very important."

c) Abstraction, when the learner has done a learning activity on the story of Visakhabucha Day. Most students have knowledge and understanding about abstract. This can be seen from a student recording the following.

"... Abstraction is a component of computational concepts which uses a process of separating important attributes from the present or task being considered. In order to obtain necessary and sufficient information for problem solving thinking ..."

d) Algorithm, when the learner has done a learning activity on the story of Visakhabucha Day. Most students have knowledge, understanding, and are able to create algorithms to solve problems. As can be seen from the fact that a student recorded.

"Writing algorithms using natural language

Begin

Character 1 says: What will the birth of the Buddha commemorate?

Character 1 sends message 1

Character 2 receives the message

Character 2 says: The Nativity of the Buddha commemorates the self-training.

End."

V. DISCUSSION

From computing course problems in the past, the researcher found students' ability to do computational thinking is unsatisfactory. When students are asked to write what they have learned. Most students write what they did in the classroom rather than decompose problems, find pattern of problems, apply abstraction and develop algorithm to problem-solving. So, we interested in developing learning activities based on STEM education for development of computational thinking of senior high school students in the computing courses. The results of the research showed that learning activities according to the STEM education approach improves the students' computational thinking skills. This is consistent with research of Chaya-karn Kirirat [7] and Passakorn Ruangrong and others [8] that found that computational thinking can be developed by allowing students to write programs. So, that students understand how to solve problems with computers and to develop students' logic and problem solving skills. This encourages students to develop thinking skills and processes that can be used to solve problems in daily life effectively. In addition, students can exchange knowledge with their classmates and teachers. Reflect by discussing and writing weekly journal. Another, teachers should encourage, support and advice students as they are confronted with problems. Teacher must try to change the attitude of students' perspective. Those problems are challenge and listen to the opinions of students, support and facilitate students to develop computational thinking by engineering designs, computer program development and ask questions to stimulate the students' computational thinking.

However, some computer language has affect to students' computational thinking. The researcher found the learning activities on the animation robots that use Python do not support computational thinking development. Because of Python syntax are too complicated syntax for students. So, students focus on writing the program correctly rather than computational thinking. Therefore, choosing a computer language that is appropriate for the learning activities and educational level of the learner must be carefully considered.

VI. CONCLUSION

From the research results, it can be concluded that learning activities according to STEM education by develop technology (product or process) with engineering design process and computer programming based on scientific, mathematics. It can develop the students' computational thinking skills in all 4 components: decomposition problems, pattern recognition, abstraction and algorithms to solve problems.

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REFERENCES

- [1] BBC. "What is computational thinking ?," Retrive from <http://www.bbc.co.uk/education/guides/zp92mp3/revision>, September 2019.
- [2] Jeannette M. Wing. "Computational Thinking," Retrive from <https://www.cs.cmu.edu/~15110s13/Wing06-ct.pdf>, September 2019.
- [3] Jose-Manuel Saez-Lopez, Marcos Roman-Gonzalez, Esteban Vazquez-Cano. "Visual programming languages integrated across the curriculum in elementary school: A two year case study using "Scratch" in five schools," *Computers & Education Journal*, Vol. 97, Issue C, pp. 129-141, June. 2016.
- [4] Po-Yao Chao, "Exploring students' compu-tational practice, design and performance of problem solving through a visual program-ming environment," *Computers & Education Journal*, Vol. 95 Issue C, pp. 202-215, Apr. 2016.
- [5] Pichet Srisangngam, "Developing 5E Instructional Model Blended Engineering Design for Enhances Critical Thinking Skills of Grade 8 Students," *Verdian E-Journal*, Vol. 11, pp. 2448-2462, Jan. 2018.
- [6] Information Technology Faculty, "Bebras Thailand," Retrive from, <https://www.it.kmitl.ac.th/th/news/6682/>, September, 2019.
- [7] Chayakan Keereerat, "Using the Problem-Solving and App Inventor to Develop Computational Thinking Skill for High School Students," *Journal of Education Studies*, vol. 47, pp. 31-47, April 2019.
- [8] Passkorn Roungrong, Rujroad Kaewurai, Sasithorn Namoun-gon, Apatcha Changkwanyun and Supasit Tengkeew, "Computational Thinking with Thai Education," *Panyapiwat Journal*, Vol.10, pp.322-330, September 2018.