Asia-Pacific Journal of Science and Technology: Volume: 23. Issue: 02. Article ID.: APST-23-02-04. Research Article

APST

Asia-Pacific Journal of Science and Technology

https://www.tci-thaijo.org/index.php/APST/index

Published by the Faculty of Engineering, Khon Kaen University, Thailand

A framework of learning achievement by STEAM education for system analysis and design in case study RMUTT

Julaluk Watthananon[1, *]

[1] Major of Computer Science, Department of Mathematics and Computer Science, Faculty of Science and Technology, Rajamangala University of Technology Thanyaburi
*Corresponding author: julaluk.w@rmutt.ac.th, watthananon@hotmail.com

Abstract

The purpose of the study were: 1) to develop framework by STEAM *(Science, Technology, Engineering, Arts and Mathematics)* education for system analysis and design, 2) to study the students' satisfaction for STEAM education teaching integrated for system analysis and design, and 3) to study students' behaviors after promotion of learning. The sample of this research was the computer science undergraduate students in the first semester of the academic year 2016 at Rajamangala University of Technology Thanyaburi. The number of samples 90 people, research tools that include: 1) lesson plans and activities plan, 2) the achievement test for pre-test and post-test in each hour, 3) the observation record of students' behaviors in classroom, and 4) the evaluation from of learning and teaching at the end of course. The results show that the post-test score was significantly higher than that the pre-test, which verified the validity and reliability by statistics of Kolmogorov-Smirnov Z test and Wilcoxon Signed Ranks Test. For learning behaviors, all of them showed their responsibility to class regularly and did other jobs during the class. Two students per class (2.22%) missed the class and three students per class (3.33%) attended the class later than 5 minutes. In summary, A Framework of Learning by STEAM education for System Analysis and Design is enhancing learning potential with the intention could help students to improve their learning achievement and behavior in the class and can be used as a tool for learning enhancement.

Keywords: Framework; STEM; STEAM; System Analysis and Design.

1. Introduction

In the current, Faculty of Science and Technology, RMUTT, delicate to develop qualifies graduates as University philosophy and National Education Act. Then the policy improving and developing effective individual course learning activities, focusing on professional Hands-on experiences, means we focused to produce people to have skilled and specialized to business and industry that response to the country's development. To do so, STEM is the interdisciplinary integration between S=Science, T=Technology, E=Engineering, and M=Mathematics learning, has been applied to enhance the better learning skills. From the researches study [3, 6, 29], is supported to developing and teaching STEM education in Early Childhood for response to the intelligence. Especially in children to developing cognitive skills in Engineering and using technology such as: iPad and Tablet to developed learning STEM education that the reports shown children in Early Childhood can develop as well [2].

Current research, there are also many teaching methods to help in the teaching of students are even more effective such as: Active-based learning, Project-based learning, and Problem-based learning, etc. But the real of problems is not teaching it's because of students' behavior that affects to the academic achievement of students such as: come too late, lack of interest, lack of practice, and do not see the value in attending. This results in the inability to apply knowledge of this subject to other subjects [26]. From the researches study [18], said one of the key successes of a student is to be promotion of learning, by the way, teacher must motivate the students periodically with the continued agreement [8, 24]. While, the research of [10] found that, if students feel that they are content

to study and read a lot of the time. It's effect to the lack of student interest and discouraging learning. Finally, they will not appreciate the value of the course.

In this research, we focused on Learning Achievement integrated with Arts of STEM teaching. The researcher was conducted experiments with System Analysis and Design using STEAM teaching to integrate and applies imagination to stimulate the thinking process and motivation of learning to develop intellectual skill. In the past, we have experiment with STEM teaching to promotion of learning [28] shown that can attract the attention of learners very well and stimulate the critical thinking. But this experiment, we believe that if we are also inherently teaching the arts. They can reach and understand the content more naturally by themselves because it is the arts of STEM to help students' achieve enjoyment, to enable students to transfer their knowledge and skill to real-world problems, to be motivated to learn, and to improve their math and science with arts. Thus, this study is the experimental research with the following objectives:

1) To develop framework by STEAM education for system analysis and design
2) To study the students' satisfaction for STEAM education teaching integrated for system analysis and design
3) To compare students' knowledge before and after promotion of learning.
4) To study students' behaviors after promotion of learning.

2. Literature Reviews

2.1 Theory of Learning

Theory of Learning is conceptual frameworks to describe how knowledge is absorbed, processed, and retained during learning [20]. In addition, cognitive, emotional, environmental influences, and background experience, all are involved in understanding is changed knowledge and skills of learner [9, 15]. Over the past century, educational psychologists and researchers [22, 25] have many theories to explain how individuals acquire, organize and deploy skills and knowledge. Example as Slavin [21] used STAD: Student Teams Achievement Divisions, it can be concluded that the technique is applicable to all subjects such as mathematics, language, arts and science. That, applies to students from grade 2 to university, suitable for use in teaching subjects that are clearly defined purpose and there is only one correct answer. It is a collaborative learning strategy in which small groups of learners with different levels of ability work together to accomplish a shared learning goal, so each student will have their own score. For the other research with constructivism theory [23] based on observation and scientific study, the constructivist view of learning can point towards a few different teaching practices. Normally, it usually means encouraging learners to use active learning techniques to create more knowledge. For this research, the researchers summarized learning theories are grouped into three basic categories: (1) Behaviorist learning theories, (2) Cognitive-information processing learning theories, and (3) Cognitive-constructivist learning theories. Therefore, this research used advantage of these three theories are applied together to design a framework of learning achievement to be effective for course system analysis and design.

2.2 21st Century Teaching and Learning

Learning in the 21st Century is a strategic guideline for learning management. The objective is to create a common format and guidelines for enhancing the effectiveness of learning, focused on knowledge, skills, and the performance with the students have higher order learning skills. Especially the evaluating skills are replaced by ability to use new knowledge in a creative way. It can be seen that, the components of students in 21st Century skills must be knowledge, skills and performance [16 -17]. Therefore, the phrase "21st Century Skills" encompasses several inter-related skill sets: life and career skills; learning and innovation skills-4Cs; information, media and technology skills; and core subject-3Rs mastery and familiarity with interdisciplinary themes include: global, awareness, financial literacy, health literacy, and visual literacy. [12] These skill sets are framed as desired outcomes for learners that are built upon standards and assessments, curriculum and instruction, teacher professional development, and learning environments [4]. As shown in Figure 1.

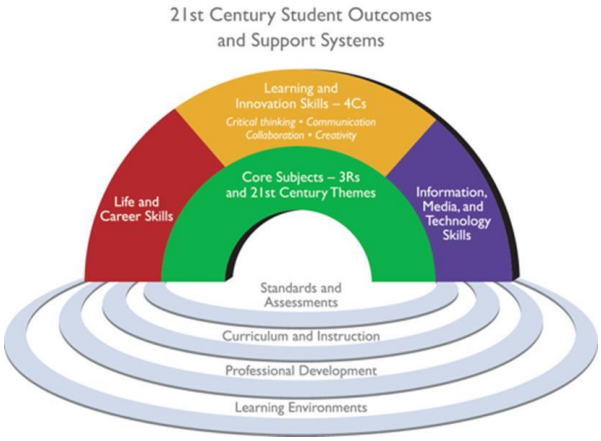

Figure 1 A Framework for 21st Century Student Outcomes and Support Systems (Diagram developed by P21)

Many research studies in United Kingdom on the role of Information and Communication Technology (ICT) in education indicate that instruction via new media stimulates student learning [1, 13], while some of research found that using 21st century tools in combination with inquiry-based learning and/or project-based learning is also an effective instructional strategy for increasing critical thinking skills and social skills [5, 27]. In turn, gains in critical thinking have been shown to produce higher academic achievement from learning by trial and error and individual exploration [30].

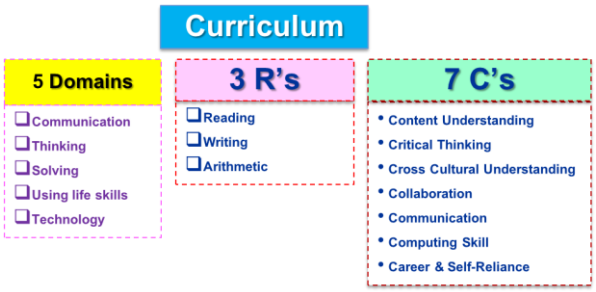

Figure 2 Thailand quality student in 21st Century

From figure 2, shown the conceptual framework of Thailand quality student in 21st Century skills provides a holistic representation of the student outcomes and support systems required to establish 21st century career and life readiness. These curriculum sets are frames according to the teaching under desirable characteristics of students in 5 domains: communication; thinking; solving; using life skills; and technology. Therefore, the policy form Ministry of Education in Thailand to push the quality of Thai students need in the 21st century [21] should be skillful in learning and innovation to long life learning was: 3Rs *(reading; writhing; and arithmetic)* and 7Cs *(critical thinking and problem solving; creativity and innovation; cross-cultural understanding; collaboration, teamwork and leadership; communications, information and media literacy; computer and ICT literacy; and career and learning skills).*

2.3 STEM education

STEM is a curriculum based on the idea of educating students in four specific disciplines: S-Science *(in experimenting of solution),* T-Technology *(in technological application),* E-Engineering *(in solving problem),* and M-Mathematics *(in mathematical calculation),* in an interdisciplinary and applied approach. It can be seen that, the concept of learning in STEM education focus on the process of thinking as a scientist. Then experiment to prove or thinking, cause and effect with mathematical principles, apply of existing tools to solve problems, and creative work or innovation with the engineering process. Form the many researches [6, 21, 29] found that, STEM instruction has incorporated activities to stimulates student learning by teacher using 21st century tools in combination with project-based learning, problem-based learning, active-based learning, and design-based learning. That, enables students to be creative and develop work well under the inquiry-based learning knowledge and scientific links. So, is that means if the teacher can use STEM education to teach how much quicker. Its will increase the ability and potential of students and more by manage the appropriate activities for the learner and the content make interested, enthusiasm, challenged, and confident in learning.

In addition, the United States has set a policy of STEM education for each state to apply in teaching and learning [14], to starting from pre-primary school level; early childhood; secondary school; and university level, so that

students can continuous convey ideas or understand the system thinking [3]. Therefore, STEM education will be the integration of the four branches as mentioned above, it also a context integration related to daily life. This will make the teaching meaningful to the learner and can be used in daily life, this will increase the chances of work, value added and strengthen the economy.

2.4 STEAM education

STEAM is an educational framework for teaching across disciplines. STEAM = Science & Technology interpreted through Engineering and the Arts, all based in mathematical elements. For the concept of STEAM education or STEM+A is to integrate cross-disciplinary teaching of STEM by incorporating Arts to stimulate learning as the result, students could convey and apply the conceptual thinking with more creativity or imagination. In the research [28] found that, the imagination is an important of learning that stimulates learner's thinking and communicate their thoughts in the form of music and movement. The teachers should be included A or Arts in STEM learning activities into the lesson because these techniques allow learners using the nature integration of Science, Technology, Engineering, Mathematic, and Arts to promote skill development in 21st century better than over. Therefore, communication with gesture language or drawing, there is an element of beauty in an appropriate proportion and aesthetic into a complete of work upon has Arts in their [19]. And the many researches studies on the role of ICT (Information and Communication Technology) in education indicate that instruction via new media stimulates student learning [1, 13]. Using 21st century tools in combination with inquiry-based learning, active-based learning and/or project-based learning is also an effective instructional strategy for increasing critical thinking [5, 27]. In turn, gains in critical thinking have been shown to produce higher academic achievement [30].

Therefore, this research is to introduce the concept of A: Arts into the teaching of STEM through a variety of learning achievement help to pre-algebra and pattern. The aim of STEM+A is to teach creative and critical thinking likewise; creativity and innovation continue to be prized skills students need in the 21st century skills and it is fundamental that teachers should focus on.

3. Methodology

This is the experiment research which follows the methodology of research cycle [11], used theory model of cognitive-information processing to design a framework of learning achievement by STEAM for SA (System Analysis and Design), the researchers focus on the critical thinking and problem solving skills because we believe "cognitive skills" differentiate the learners from the good students or weak students. So, there are consists of four steps: Input, Process, Output and Feedback. As shown in Figure 3.

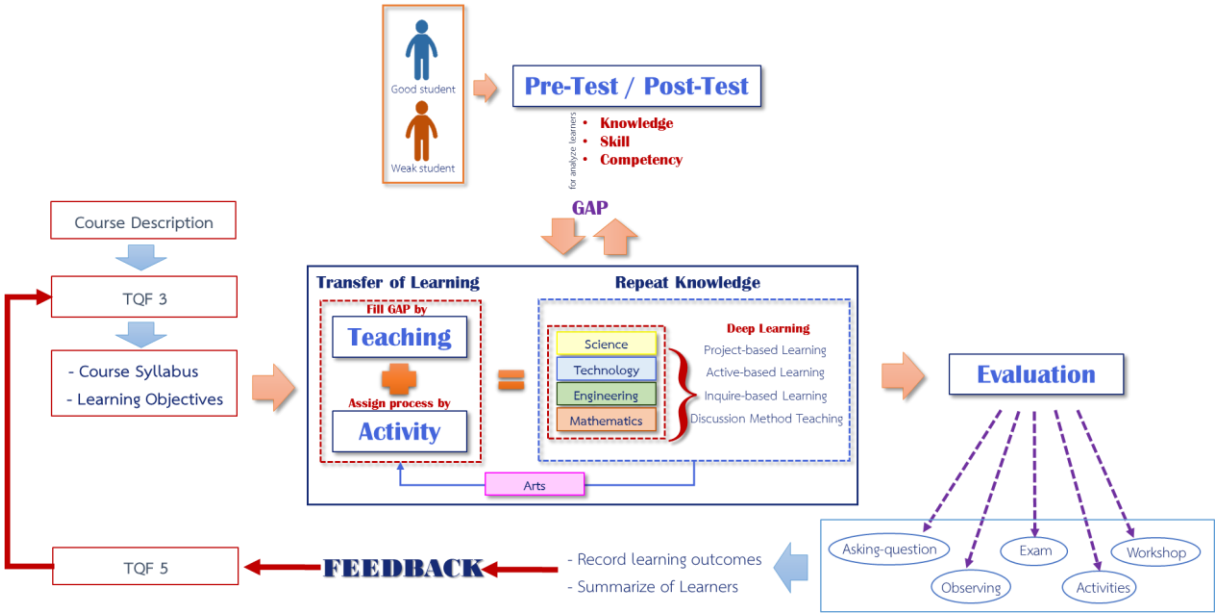

Figure 3 A Framework of Learning Achievement by STEAM for System Analysis and Design

From figure 3, this framework, the researcher developed out of our educational experiences and experimental in classroom to solving of teaching comprises two components: 1) interdisciplinary approaches to solving of teaching and 2) accessible learning activities. This can be explained four steps as follows:

Step Input: Input is a piece of data which is initial to analyze before teaching. There are various types of input data are: course description, TQF_3, course syllabus, and learning objectives.

Step Process: In this step, the process is divided inside into two parts: 1) pre-test or post-test of the learner that to know the knowledge, skill and competency of each student. To analyze GAP analysis of assessing the differences in performance between good students or weak students to determine whether learner differences are being met and, if not, what steps should be taken to ensure they are met successfully. 2) transfer of learning to fill GAP analysis by teaching technique and stimulates student learning by activity in each content. And using repeat knowledge in science, technology, engineering and mathematics have been shown to produce higher academic achievement in combination with deep learning techniques by project-based learning, active-based learning, inquire-based learning and discussion method teaching is also an effective instructional strategy for increasing critical thinking, collaboration, communication and solving problem. We believe cognitive skills are important for everyone, but it's not enough to educate a few highly skilled or knowledge. Therefore, we should be encouraged their something has to be learned by activity, its will be able to recognize, understand and solve problems in a systematically.

Step Output: Output is the result of the student's evaluation of the teaching and score of activities in class such as: asking-question, observing, exam, activities and workshop. In this step is the evaluation between teaching and learning, it aims to monitor the learning and progress of learners or improved the quality of learning.

Step Feedback: This step is a summary evaluation at the end of the course. So, the purpose is to evaluate learners' learning achievement. Therefore, Feedback is the result of recording the learning outcomes and summarize of learners in TQF 5 to improve the learning process in the next term, so this result it's become to the data to input step again for created and planning indicators. Therefore, the researcher has experimented and improved this process more than 3 years is become to this framework.

4. Experiments and Results

Experiment focus on comparison of students' knowledge score pre-test and post-test, which analysis using Wilcoxon Signed Ranks Test because of the preliminary test by Kolmogorov-Smirnov Test found that the scores were not distributed into regular curves, as the follow:

4.1 Data

This is a quantitative study to develop framework by STEAM *(Science, Technology, Engineering, Arts and Mathematics)* education for system analysis and design. The 90 students were selected with the cluster-sampling method [7]. These students enrolled in semester 1 academic year 2016 and registered for course of SA: System Analysis and Design as required by curriculum.

4.2 Tools

The data was collected by:

- The lesson plans and activities plan,
- The achievement test for pre-test and post-test in each hour,
- The observation record of students' behaviors in classroom, and
- The evaluation from of learning and teaching at the end of course.

4.3 Results

The results of students' knowledge score, in the main content of System analysis and Design with 90 people for before and after promotion of learning, found that the pre-test had *Mean = 9.11, SD was calculated as 2.23,* while the post-test had *Mean = 14.17, SD was calculated as 1.89.* This means the students have more knowledge after their got promotion of learning, is shown in Table 1.

Table 1 Comparison Students' knowledge score

Score	Mean	Median	Mode	SD
Pre-test	9.11	9.00	8.00	2.23
Post-test	14.17	14.00	15.01	1.89

From Table 1, the researcher used that the results to test distributed of the score by Kolmogorov-Smirnov Z test. The research found that the scores were not distributed into regular curves. Therefore, we were using Wilcoxon Singed Ranks Test to compare difference analysis between Mean effectiveness of pre- and post promotion of learning. We focused on outcomes from promotion of learning found that, the score of knowledge in this subject after promotion of learning (post-test score) was significantly higher than that the pre-test in statistical significance at .001 *(Z = -11.17, p<.001)*, is shown in Table 2.

Table 2 Difference Analysis Mean Effectiveness Between pre- and post-Promotion of Learning.

Score	*N*	*Mean Rank Test*	*Sum Rank Test*	*Z*	*p-value*
Post > Pre	84	83.83	13,980.0	-11.17	< .001
Post < Pre	2	9.30	37.9		
Post = Pre	4				
Total	90				

For students' behaviors in classroom we found that, all of them showed their responsibility to class regularly and did other jobs during the class. Two students per class (2.22%) missed the class and three students per class (3.33%) attended the class later than 5 minutes, when considering in each hour it was found that the student have more cooperation and interested with the lesson if we are teaching STEM, we are also inherently teaching the Arts. For activities or their works, it may be the creative piece that gives them the spark they need to truly engage, this results in a motivated of learning by the Math, the Science, or even the Technology. As shown in Figure 4.

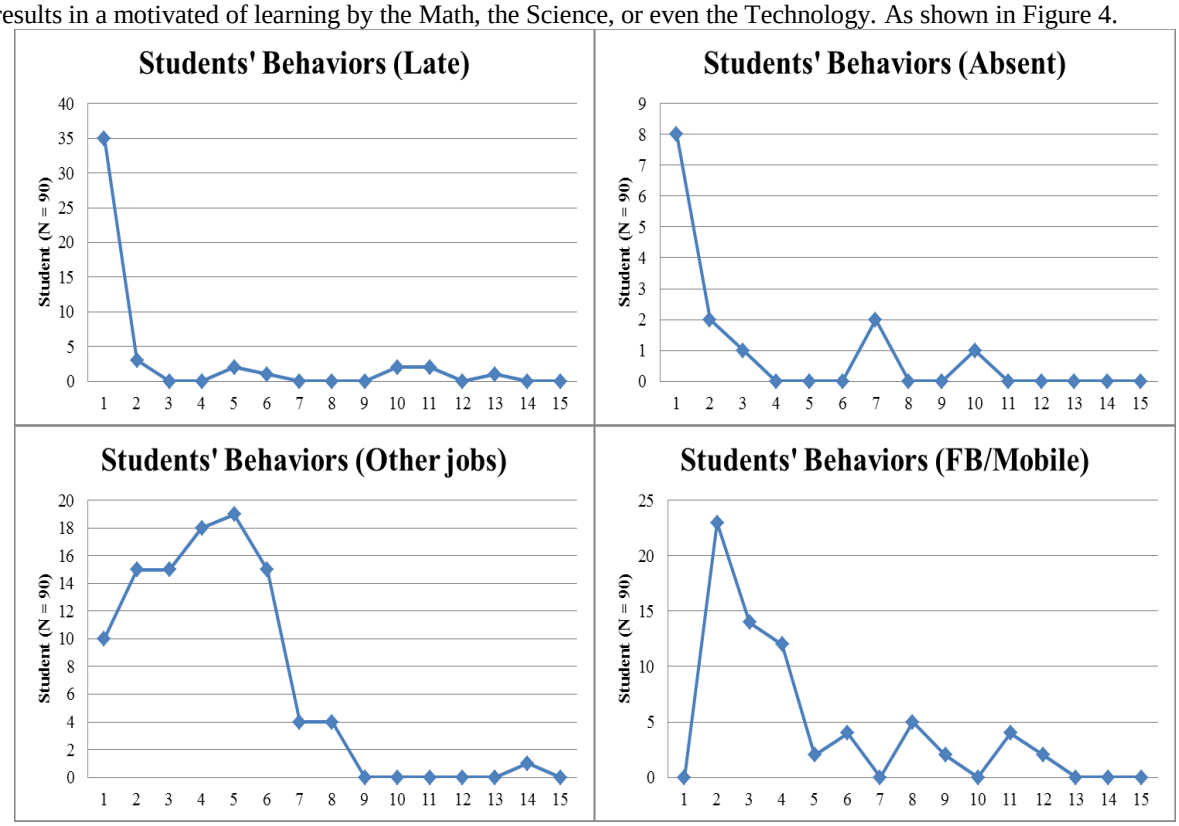

Figure 4 Students' Behaviors in classroom for 1 semester.

For learning outcomes, the researcher focused on critical thinking, creativity, collaboration, communication and the atmosphere of workshop in classroom. We evaluated questionnaires, learning behavior observation and creativities of portfolio assigned all consists of activities, workshops, lectures, homework, simulation, interview, feedback, present and creating. Therefore, the result of the evaluation of STEAM teaching is high level of scores for every item, specifically with the item of Arts activities in classroom have been assessed at the highest level was 4.31 and is shown in Table 3.

Table 3 The Evaluation of STEAM teaching

Item to Evaluation	Score	Meaning
1. Motivated of learning by Math	3.87	High
2. Motivated of learning by Science	4.11	High
3. Motivated of learning by Technology	3.78	High
4. Motivated of learning by Engineering	3.76	High
5. Arts activities in classroom	4.31	Highest
6. Teaching in this course is appropriate	3.98	High
7. The value of content in each hour	4.01	High
8. Quantity and Assignment are appropriate	3.86	High
9. Evaluation is appropriate	3.98	High
10. Overview of this course	3.91	High

5. Conclusions

As the results, for students' knowledge score and students' behaviors in classroom of learning achievement by STEAM education for System Analysis and Design shown that, the overall achievement of the students taught by arts of STEM was high and their had responsibility to class regularly and did other jobs during the class. Therefore, teacher should include arts of STEM learning activities in the content of the lesson. Because its help the learner to combine their knowledge based on scientific critical thinking very well, that cause and effect base on mathematics, through artistic design, apply by technological tools, and solve the problem with the process by creating innovation in engineering. Arts of STEM to help students achieve enjoyment, to enable students to transfer their knowledge and skill to real-world problems, to be motivated to learn, and to improve their math and science with arts. Therefore, teachers must used teaching methods such as Project-based Learning, Problem-based Learning and Design-based Learning in classroom for help or motivation learners can be creative and develop the work well. Its that means, if the teacher can used STEM or STEAM education to teach how faster it, their will have a lot of talent and more potential learners. While in some states of the United States, STEM and STEAM education has been introduced at pre-school level.

Advantage: This teaching technique it allows students to connect their learning in these critical areas together with arts, practices, elements, design principles, and standards to provide the whole pallet of learning their disposal. STEAM education, removes limitations and replaces them with wonder, critique, inquiry, and innovation.

Disadvantage: This approach to learning is certainly not an easy task, for our research found that, it is difficult to control the time and motivated to the lesson because it depends on the skills and experience of the teacher. Therefore, teachers need time to prepare for teaching, design and plan learning by activities that consistent and enhancing scientific critical thinking, as well as the provision of equipment and resources to be appropriated for the learning.

In summary, A Framework of Learning by STEAM education for System Analysis and Design is enhancing learning potential with the intention could help students to improve their learning achievement and behavior in the class and can be used as a tool for learning enhancement. STEAM teaching and learning that promotes such sustained engagement, imbuing all students with a belief that they can better their own lives and others through.

6. Acknowledgment

This research was conducted as part of the professional development for major in Computer Science, Department of Mathematics and Computer Science, with support from Faculty of Science and Technology, Rajamangala University of Technology Thanyaburi.

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