

Learning Management Through the Combination of STEAM Education and Phenomenon-Based Learning to Develop Creative Thinking of Secondary 6 (Grade 12) Students

Sayrung Tongsoong, Rossarin Jermtaisong*

Faculty of Technical Education

Rajamangala University of Technology Thanyaburi

Pathumthani province, Thailand

sayrung_t@mail.rmUTT.ac.th, *Rossarin_J@rmUTT.ac.th

Abstract—Learning management based on STEAM Education is the integration which combined the knowledge to the real phenomena. In this research. In this research, The purposes were to: 1) develop learning management of STEAM education combined with phenomenon-based learning, 2) compare creative thinking in Physics before and after traditional learning management, 3) compare creative thinking in Physics before and after learning management through the combination of STEAM Education and Phenomenon-based learning, and 4) compare creative thinking in Physics after studying through STEAM education combined with phenomenon-based and traditional learning management. Research sample was two classes, selected by cluster random sampling, of secondary 6 (grade 12) students in the first semester of the academic year 2020. The research instruments consisted of learning management plans, creative thinking tests in science and creative work evaluation form. The results revealed that The results revealed that 1) STEAM Education and Phenomenon-based learning consisted of 6 steps - 3PA., 2) creative thinking in Physics for students studying through traditional learning management showed that the after study was higher than the before study, 3) creative thinking in Physics for student studying learning management through the combination of STEAM Education and Phenomenon-based learning showed that the after study was higher than the before study, and 4) creative thinking in Physics for student studying of the learning management through the combination of STEAM Education and Phenomenon-based learning showed higher than the traditional learning management.

Keywords—STEAM education, phenomenon based learning, creative thinking

I. INTRODUCTION

In the 21st century, the world changes rapidly because of new technologies and knowledge. It makes changes in the living context and education. In retrospect, teachers teach

through the transmission of knowledge. Nowadays, teachers are responsible for facilitating students, students use technology and tools to quest for knowledge rather than textbooks. The advancement of communication technology, learners are able to research their own knowledge from various learning sources and learn at any time they want. Society of learning has changed, the classroom is no longer just a book. Students have laptops, tablets, iPads, and smartphones to get in touch with Technology in the 21st century, leading the world to revolutionize the old industry to the digital world. The demand of the labor market has changed, learning in the classroom isn't enough.

Thailand is facing with new economic, social, political, technological, energy and environmental changes. We have to keep up with the industry 4.0. This turning point is another important step forwards for Thailand and neighboring ASEAN countries to prepare for the trend of relocation of production bases and adopting robot technology and automatic mechanical systems to replace the dependence on cheap labor. It is estimated that by 2030 more than 375 million workers worldwide may have to change professions or disappear especially workers who are unable to adapt in time [1]. At the same time, in the 21st century, there will be new and more highly skilled jobs. Producing and developing workforce skills to meet rapidly changing market demands is essential in today's world.

Preparing the young generation with 21st century skills, including critical thinking, communication, collaboration, and creativity. Life and professional skills are always changing [2]. These are important and also one of the most important skills in the 21st century that must be developed and promoted to meet towards the modern world that focuses on business and innovation. It is transformative and highly competitive with the creative skills necessary to cultivate citizens of the country.

Such skills encourage people to see their surroundings and to apply their knowledge to develop new and different products appropriately. As a result, creativity is one of the 21st century skills that should be developed for young people [3]. The economic policy of Thailand 4.0, Thailand will be able to step forward from a middle income to a high income country by innovation. It requires manpower with qualifications for handling raw materials and resources. There is a systematic work, strange fantasy and multimedia implementation [4].

The Equitable Education Fund revealed that employability skills most required by the 21st century are critical thinking and creativity, these skills provide a competitive advantage and technology which cannot be replaced [3]. According to the results of the 2014, employer needs survey of employers and Emerging Organizations of the Organization for Economic Cooperation and Development (OECD) [5], who initiated Programmed for International Student Assessment: PISA. Creative thinking means thinking outside the box. Often, creativity involves lateral thinking, which is the ability to perceive patterns that are not obvious. Creative thinking might mean devising new ways to carry out tasks, solve problems, and meet challenges. It means bringing a fresh, and sometimes unorthodox, perspective to your work. This way of thinking can help departments and organizations be more productive [6].

The Third External Quality Assessment (2011-2015) of the General Basic Education Schools of Thailand found that students still lack research skills creativity, innovation and invention. Therefore, there is a focus on skill development, analytical thinking, creative developing, innovation and responsibility for learning activities in the classroom. Under the 20-year National Strategy Framework (2017 - 2036) and directional framework of the 12th National Economic and Social Development Plan (2017 - 2021) [7]. From that problems it was shown that students lack scientific support for creativity. This is the result of teach management that focuses on content and facts. For this reason, civic development and manpower of quality science and technology. Youth need to be trained in thinking processes and develop teaching processes suitable for creative thinking. Especially in creative thinking of science, teacher must be giving the student an opportunity to do by themselves, provide opportunities for learners to set academic goals, Self-knowledge, select and filter information, construct and apply knowledge, including assess their own learning [8].

Development of learners to such skills one concept used in learning management is STEAM Education, an approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, critical and creative thinking. The STEAM Education Process, there are actually 6 steps to creating a STEAM-Centered classroom, no matter what area you teach. In each step, you're working through both the content and the arts standards to address a central problem or essential question.

- Focus: In this step, we're selecting an essential question to answer or problem to solve.
- Detail: During the detail phase, you're looking for the elements that are contributing to the problem or question.
- Discovery: Discovery is all about active research and intentional teaching.
- Application: After students have dived deep into a problem or question and have analyzed current solutions as well as what still needs addressed, they can begin to create their own solution or composition to the problem.
- Presentation: Once students have created their solution or composition, it's time to share it.
- Link: Students have chances to reflect on the feedback that was shared and on their own process and skills [9].

Phenomenon-based learning has its origins in a 2016 education movement in Finland's educational system. The revised education system asks that students take one module each year with the Phenomenon-based learning approach. The purpose is to better prepare students for real life. It is a learner-centered, multidisciplinary instructional approach that is based on student inquiry and problem solving. No specific subject is taught, nor is there any preset learning objective. Instead, learners investigate and solve their own questions by applying what subjects are relevant to the problem [10]. Approach of Phenomenon-based learning consisted of 4 steps: 1) select an interesting phenomenon 2) analyze the utility of your existing lessons 3) plan a sequence of activities and 4) make a plan.

The above mentioned problems and importance, the researcher is interested to learning management through the combination of STEAM education and Phenomenon-based learning in electrostatic to development creative thinking in Physics of secondary 6 (Grade 12) Students at Sakao School, Thailand.

II. RESEARCH OBJECTIVES

These objectives of this research were 1) develop learning management of STEAM education combined with Phenomenon-based learning for secondary 6 (grade 12) students, 2). Compare creative thinking in Physics before and after traditional learning management, 3). Compare creative thinking in Physics before and after learning management through the combination of STEAM Education and Phenomenon-based learning, and 4). Compare creative thinking in Physics after studying through STEAM education combined with phenomenon-based and traditional learning management.

III. RESEARCH METHODOLOGY

This research is a Pretest-Posttest control group Design, Research sample was two classes of secondary 6 (grade 12)

students in the first semester of the academic year 2020 studying at Sakaeo School, Sakaeo province, Thailand selected by cluster random sampling. The total number was 70 students and was divided into 2 groups as experimental group and control group. Each group contained 35 students. Studied variables include

Independent variables are two methods of management learning. Including 1) the combination of STEAM education and Phenomenon-based learning management (3PA) 2) traditional learning management.

Dependent variable is a creative thinking in Physics, which consisted of fluency, flexibility, originality, and elaboration.

The research instruments consisted of 1) traditional learning management plans, 2) learning management through STEAM education combined with Phenomenon-based learning plans consisted of 6 plans in electrostatic unit which took 22 periods, 3) Creative thinking tests in science (Pre-Posttest) which consisted of 5 questions and 4) Creative work evaluation form.

Mean, percent, S.D., T-test Independent and T-test Dependent were used for data analysis.

IV. DATA ANALYSIS RESULTS

A. The Results of the Development of Learning Management Through the Combination of STEAM Education and Phenomenon-Based Learning

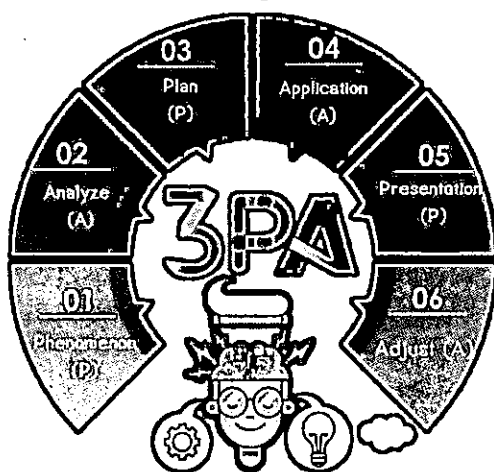


Fig. 1. The 3PA design process to develop creative thinking

In Fig. 1. The development of learning management through the combination of STEAM Education and Phenomenon-based learning consisted of 6 steps (3PA):

Step 1 Phenomenon (P); have learners choose a "phenomenon" from the real world; the topic should have a global context and be related to real life issues or events.

Step 2 Analyze (A); Teachers and students have already acquired phenomena and situations that need answers. Bring questions to analyze for details or find elements of why the problem or question arises from existing knowledge.

Step 3 Plan (P); Students study and research the information they need to come up with answers or solutions in different ways by discussing them with students to explore ideas and ask questions.

Step 4 Application (A); this is where students create and explain how to solve a problem. At this stage, students demonstrate the skills and knowledge gained through creative work.

Step 5 Presentation (P); Students publish and share their work or perspective of the solution, concept, and application of knowledge to create works for others. People who view the work have the opportunity to give advice or suggestions to the presenter. This helps students learn to give and receive advice.

Step 6 Adjust (A); Students have the opportunity to reflect on the suggestions gained from the previous step by bringing suggestions to improve their work or solutions to produce better work or solutions.

B. The Results of Data Analysis to Compare Creative Thinking in Physics Before and After Traditional Learning Management

TABLE I. COMPARISON OF CREATIVE THINKING IN PHYSICS BEFORE AND AFTER TRADITIONAL LEARNING MANAGEMENT

Traditional learning management	n	\bar{X}	S	t	df	Sig
before	35	43.51	12.09	14.06*	34	0.000
after	35	62.71	9.06			

*p < 0.05

From Table 1, the results revealed that the post-test scores of creative thinking in Physics of Secondary 6 (Grade 12) students was) $\bar{X} = 43.51$, $S = 12.09$ (higher than the pre-test) $\bar{X} = 62.71$, $S = 9.06$ (. The creative thinking in Physics of students studying through traditional learning management showed that the after study scores was higher than the before study statistically significant difference at the level of .05.

C. The Comparison of Data Analysis Results between Before and After Learning Management through the Combination of STEAM Education and Phenomenon-based Learning Compare Creative Thinking in Physics.

TABLE II. COMPARISON OF CREATIVE THINKING IN PHYSICS BEFORE AND AFTER LEARNING MANAGEMENT THROUGH THE COMBINATION OF STEAM EDUCATION AND PHENOMENON-BASED LEARNING (3PA)

3PA	n	\bar{X}	S	t	df	Sig
before	35	43.80	11.52	14.41*	34	0.000
after	35	67.17	7.81			

*p < 0.05

From Table 2, the results revealed that the post-test scores of creative thinking in Physics of Secondary 6 (Grade 12) students was $\bar{X} = 43.80$, $S = 11.52$ (higher than the pre-test) $\bar{X} = 67.17$, $S = 7.81$. The creative thinking in Physics of students studying through the combination of STEAM Education and Phenomenon-based learning showed that the after study scores was higher than the before study statistically significant difference at the level of .05.

D. The Data Analysis Comparison of the Creative Thinking in Physics After Studying Through STEAM Education Combined with Phenomenon-Based and Traditional Learning Management

TABLE III. COMPARISON OF CREATIVE THINKING IN PHYSICS AFTER STUDYING THROUGH STEAM EDUCATION COMBINED WITH PHENOMENON-BASED (3PA) AND TRADITIONAL LEARNING MANAGEMENT

Management of learning after classes	n	\bar{X}	S	t	df	Sig
Traditional learning	35	62.71	9.06	2.20*	68	0.015
3PA	35	67.17	7.81			

* $p < 0.05$

From Table 3, the results revealed that post-test scores of creative thinking in Physics of Secondary 6 (Grade 12) students studying through the Combination of STEAM Education and Phenomenon-based learning was ($\bar{X} = 67.17$, $S = 7.81$) higher than the post-test score of the traditional learning ($\bar{X} = 62.71$, $S = 9.06$) This showed that creative thinking in Physics of students studying through the combination of STEAM Education and Phenomenon-based learning was higher than the traditional learning management statistically significance difference at the level of .05.

V. RESULTS OF THE DISCUSSION

- The development of learning management through the combination of STEAM Education and Phenomenon-based learning (3PA) is a learning management that increases the students' creative thinking in Physics. The 3PA approach consisted of 6 step: Phenomenon (P), Analyze (A), Plan (P), Application (A), Presentation (P), and Adjust (A).
- Creative thinking in Physics of students studying through traditional learning management showed that the after study was higher than the before study statistically significant difference at the level of .05. This may be due to traditional learning management is process that teachers conduct, control, and manage everything. Teacher would follow all instructions as the teacher manual provided as shown in IPST [11] consisted of 5 steps: warm up, practice, conclusion, and evaluation.

- Creative thinking in Physics of students studying through the combination of STEAM Education and Phenomenon-based learning showed that the after study scores was higher than the before study statistically significant difference at the level of .05. This is in accordance the set assumptions due to the benefits of STEAM education process. STEAM is the learning management conducted through activities integrating learning science, mathematics, technology, arts and engineering design process all together. Phenomena around the students are brought into the process to help stimulate the students' desire in studying. This led to the integration of what the students have in their minds into all activities provided to develop cognition and skills in science, mathematics, technology, and creativity. Design of work pieces which the is the main characteristics of the situation from the actual phenomenon corresponding to the lesson content. It is used to stimulate students' interest to investigate and acquire knowledge to solve problems. There are 6 situations in the lesson, it was found that the situation of lightning killed over 2,000 people in India called for the most intention. This situation caused the biggest number of the death people occurred in the country. Students were taken the role of researchers and they had to find out the causes and solutions. What they need to get from the research result were safety equipment for people. The principle of electrostatics would be employed and implemented so that the students could understand the phenomenon and this resulted in innovation of safety equipment for lightening. This finding is in accordance with the research results of [12], it was found that the students' mean score of the post-test on biology achievement and scientific creativity were higher than mean score of the pre-test at the statistical significance level of .01 and the students' satisfaction towards STEM Education approach was at the high level.

- Creative thinking in Physics of students studying through the combination of STEAM Education and Phenomenon-based learning showed higher mean score than the traditional learning management statistically significant difference at the level of .05. This is right to the set assumptions. Due to the learning management, the combination of STEAM education and Phenomenon-based learning (3PA) consisted of 6 steps: Phenomenon (P), Analyze (A), Plan (P), Application (A), Presentation (P), and Adjust (A). The 3PA approach helped encourage learners to develop critical thinking, collaboration, communication, and especially creativity as well as students to construct knowledge by themselves utilizing the phenomena occurred around them as the stimulus. The learners had chances to do the trial and error on their own. Therefore, with this methodology, the creative thinking in physics was higher than the traditional learning management. Initial learning by questioning or presenting a phenomenon

(for example, COVID-19 phenomena and thunder), students find the answers to their interest phenomena together. This can be started by proposing a question or presenting some interesting problems, students help each other in solving problems in which they can bring theories into practice. They can be able to search and find out what they really want to know and/or are interested in. This would be the way they can learn and construct their own knowledge indeed.

VI. CONCLUSION

Learning management through the combination of STEAM education and Phenomenon-Based learning (3PA) that the researcher created, it is a child center learning management through the Phenomenon-Based Learning which from the real world that is observed, studied and brought into the classroom to be examined. Silander [10] said that the real-world phenomena are studied as natural phenomena, science phenomena, economic phenomena, media and technology, human, and energy provide the starting point for learning by constructivism. Through the STEAM Education, Yakman [13] said that this learning that uses Science (S), Technology (T), Engineering (E), the Arts (A), and Mathematics (M) as access points for guiding student inquiry, dialogue, critical thinking, and creative thinking. It also encourages students to work together in groups this allows students to learn by doing the activities themselves. Students can express their opinions freely and share their knowledge with their peers in the group and outside the group. The 3PA approach consisted of 6 step: Phenomenon (P), Analyze (A), Plan (P), Application (A), Presentation (P), and Adjust (A), is a learning management that can greatly to develop students' creative thinking. To support this 21st century skill.

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Authors

Sayrung Tongsoong, Rossarin Jermtaisong

Corresponding Author

Rossarin Jermtaisong

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