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Promoting productive thinking and physics learning achievement of high school students through STEAM education

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ABSTRACT

Through STEAM education, this action research aims to improve senior high school students' ability to think critically and learn effectively. The target group for this study consisted of 36 senior high school students from one school in Thailand. A STEAM education lesson plan, a test of productive thinking, and a test of learning achievement were used as research tools. Statistics tools including mean, standard deviation, and percentage were used to analyze the data. The study showed that throughout the first and second cycles, students had scored 51.16% and 65.15% on the productive thinking scale respectively. The learning organization improved the academic performance of the students in each cycle. It is reasonable to infer and consider the potential that STEAM education can support students' intellectual development. It is useful for scientific instruction in schools, but teachers also need to be knowledgeable about how to organize their classes.

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1. INTRODUCTION

Over the past century, science educators have learned a lot and shared what they've learned through education and instruction. With the goal of making people more knowledgeable and promoting learning in general. Currently, we learn about supporting parts in an online culture and a world where information has no borders and is less accessible through various kinds of learning channels. This has caused rapid changes in how science is taught and learned in the 21st century classroom. These shifts have begun to have a significant impact, requiring

learners to know how to adapt and seek knowledge through the scientific process with more necessary skills (Nuangchalerm, 2015; Supena et.al., 2021).

Learners have to know how to adapt and seek knowledge through the scientific process with the necessary skills. An important part of productive thinking in a science lesson is getting students to think critically, creatively, and independently while using scientific methods and ideas to solve problems and explore new ideas. In a science classroom, the following methods could be used to encourage thinking. Empower students to ask and answer open-ended questions that involve deeper thinking, analysis, and assessment by asking them to do so themselves and encouraging them to do so (Fausan et.al., 2021; Voorhees et.al., 2022).

The productive thinking, students should have experiments and they should be able to plan and run their own experiments to test their own ideas and learn more about science (Husnaini & Chen, 2019; Meyer & Norman, 2020). Science classroom should allow students to keep a record of their findings, to think critically about their findings, and to develop conclusions based on the facts (Manz et.al., 2020, Kwangmuang et.al., 2021). That is, learning environment should encourage students to work together by having them work in pairs or small groups to come up with ideas, share their thoughts, and find solutions to problems (Prince et.al., 2020). Students can benefit by learning from one another, building on one another's abilities, and developing their ability to think critically if they do so (Quigley & Herro, 2019; Bertrand & Namukasa, 2020; Wilson et.al., 2021).

Students should get feedback on their work that is both positive and helpful, with an emphasis on how important scientific methods and reasoning based on evidence are. Employing examples from the actual world or real-life situations, students can learn when teaching them how to link scientific principles to everyday lives. It is very helpful to include examples from the real world and case studies. Students might be able to better understand the connection of science to their own lives and be encouraged to think critically about the world that surrounds them (Stehle & Peters-Burton, 2019; Sharon & Baram-Tsabari, 2020; Queiruga-Dios et.al., 2020). In general, a key part of productive thinking in a science classroom is getting students to think creatively and critically, ask questions, and look into scientific issues through experimentation and teamwork.

Instead of focusing on memorization, the way education is run around the world should teach students how to think critically. They should have the capacity to think, evaluate, and be rational, as well as the ability to comprehend and learn in an appropriate manner. Learning to be creative and figuring out different ways to advertise their idea as a commodity in the form of goods. It is one of the concepts that is unique in a constructive way, is practical, and can be implemented for the benefit of both the individual and society as a whole. The concept of productivity holds that a person's mental capacity to generate a picture or something tangible that can be used to solve a problem or used to one's advantage in a variety of activities constitutes that person's productive capacity.

The researchers studied learning active management styles that were suitable for the development of students' productive thinking. It was found that learning management should be holistic, focusing on the integration of students' lifestyles (Listiana et al., 2019; Nuangchalerm et al., 2020). Yakman (2008) stated that STEM integrated learning is difficult to understand, but it can be occurred in the school science. Therefore, the STEAM model has been developed from the original STEM by improving the integration structure, adding art into it. Kim & Park (2012) stated that the relationship between science that focuses on academic thinking and art that focuses on creativity is perfectly combined. The steps for organizing

learning activities are as follows: identify a challenge, explore ideas, plan and develop, test and develop, test and evaluate, and present the solution. It can be seen that the process of organizing activities according to the method of steam education. There are steps that are similar and related to the elements and implications of productive thinking.

The researchers realized the problem and the need to develop the ability to think productively. The researcher is therefore interested in developing the productive thinking ability of Senior high school level 4 students who have been managed according to the STEAM education approach to be useful for developing group learning management.

2. METHOD

Participants

Thirty six of grade 10 students, Semester 2, Academic Year 2021 from Borabue School, Borabue District, Mahasarakham Province under the Office of the Secondary Educational Service Area 26.

Research instruments

Learning management plan based on steam education on momentum and collisions senior high school level 4, 8 learning plans, including 12 hours of teaching time, with the appropriateness of the learning management plan between 4.95-5.00 and very good quality level.

Productive thinking test which is created based on the measurement principle based on 3 components: planning, working agility, and quality of work. The nature of the measure is a subjective test. Eight sets of situational analysis adjusted according to Pongsuphan (2018) approach by finding the index of consistency (IOC) of the measurements. Difficulty in the range was 0.47-0.60, power discrimination in the range was 0.48-0.56, the reliability value was 0.71.

The researcher made a test to measure how well people learned, which was used to measure how well people could learn. Which cognitive processes-memory, comprehension, application, and analysis—include There are 30 items in all, divided into 4 multiple-choice exams. The test's index of consistency ranged from 0.67 to 1.00, while its difficulty ranged from 0.37 to 0.83 and its discriminating power ranged from 0.23 to 0.57. The learning accomplishment test's overall version has a reliability score of 0.78.

Data collection

This research aims to study the ability to think productively and develop learning achievement by learning management according to a steam education approach on momentum and collisions. For junior high school level 4 students, the data collection was conducted in two phases

Cycle 1: The course of learning the researcher observed student behavior using post-teaching recordings. At the end of the instructional learning management Cycle 1, the researcher collected data using the productive thinking ability test created by the researcher as a subjective model. Situation pattern, 4 items, 15 items of learning achievement test, and a record after learning management at the end of the teaching. The researcher therefore uses the information obtained from the data collection. Recording after learning and the productive thinking ability test then summarizes the information that has been used to improve, correct and develop for use in organizing the next learning activity.

Cycle 2: Using post-teaching recordings, the researcher tracked student behavior throughout the learning process. The productive thinking capacity test that the researcher devised served as a subjective model for data collection at the conclusion of the second cycle

of learning management in teaching. situational pattern, four components, fifteen elements on the learning accomplishment exam, and a record following the conclusion of learning management in the classroom. As a result, the researcher makes use of the data collection's information. The information that has been utilized to enhance, correct, and develop is summarized following learning and the test of productive thinking capacity so that it may be used to plan the following learning activity.

Data analysis

The researcher analyzed the data divided into 2 parts. Productive thinking quantitative data analysis the data were analyzed by statistics, namely mean, percentage and standard deviation. Learning achievements on momentum and collisions quantitative data analysis is the use of data from data analysis with basic statistics such as mean, percentage and standard deviation.

3. RESULT AND DISCUSSION

According to the study of the problems in productive thinking ability of students who were taught according to the steam education approach, which had 3 factors, it was found that students had the average scores for each component as shown in Table 1.

Table 1 Productive thinking

Components / Scores	Planning (4)		Fluent practice (4)		Quality of work (4)		Total (12)		%	
Score in each cycle	1	2	1	2	1	2	1	2	Cycle 1	Cycle 2
	2.17	2.78	2.09	2.65	1.91	2.39	6.17	7.82	51.16	65.16

This study found that teaching phase 1 separated by components of productive thinking.

1. On average, the pupils were given a score of 2.17 points for their planned work. It was discovered that the students had achieved an average score of 2.78 out of a possible score of 4 during the second cycle of instruction. The students in Teaching Cycle 1 were able to identify problems in the scenario; however, they were unable to find a solution to those problems. This is due to the fact that at this stage, they are required to combine a wide variety of theoretical concepts and mathematical principles in order to plan. The pupils need to be guided and directed by their teachers so that they may design solutions to the dilemma. The majority of pupils showed marked academic growth throughout Cycle 2. Some of the students who did not significantly improve their results did so because they still lacked the sequence of actions to solve issues, knowledge, and the ability to search for information in a way that did not satisfy the objectives as they should have.

2. The students' average score for working fluently throughout Cycle 1 was 2.09 points, giving them a passing grade overall. After teaching Cycle 2, it was found that students scored an average of 2.78 out of a possible 4. This shows that the students did well. Even though they don't know everything, students can name the parts of the manufacturing process, such as the materials and the machines. During the planning stage, students are able to come up with solutions because teachers have to help them. During the second round of instruction, the majority of the pupils made progress. Nonetheless, there are still certain children that require the guidance of their teachers.

3. Overall, the students did about as well as an average of 1.91 points in the first cycle of lessons. It was found that the students' overall performance in Phase 2 instruction led to an average score of 2.39 out of a possible 4. The majority of students had never developed a

product before, which resulted in the lowest average score for the teaching cycle 1 at this level; The majority of students will only design based on what they have experienced in the past, which results in their work not being original. In the second phase of instruction, it was discovered that, from the productive thinking test, the students' scores tended to increase because they were able to create works that met their objectives but lacked novelty and interest. This was discovered as a result of the fact that they were able to create works that met their objectives.

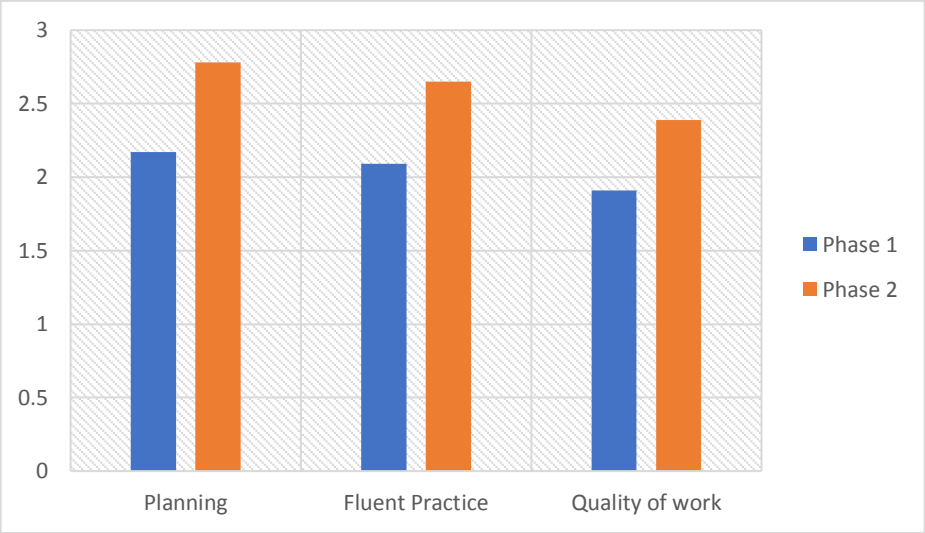

Figure 1 Average score for each factor of productive thinking

The teaching in Phase 1, students had a total average score of 51.16% and by teaching Phase 2, students had a total average score of 65.16%, which showed that students tended to have higher development. A study of physics learning achievement of students who were managed according to the steam education approach. The results were found as shown in Figure 2.

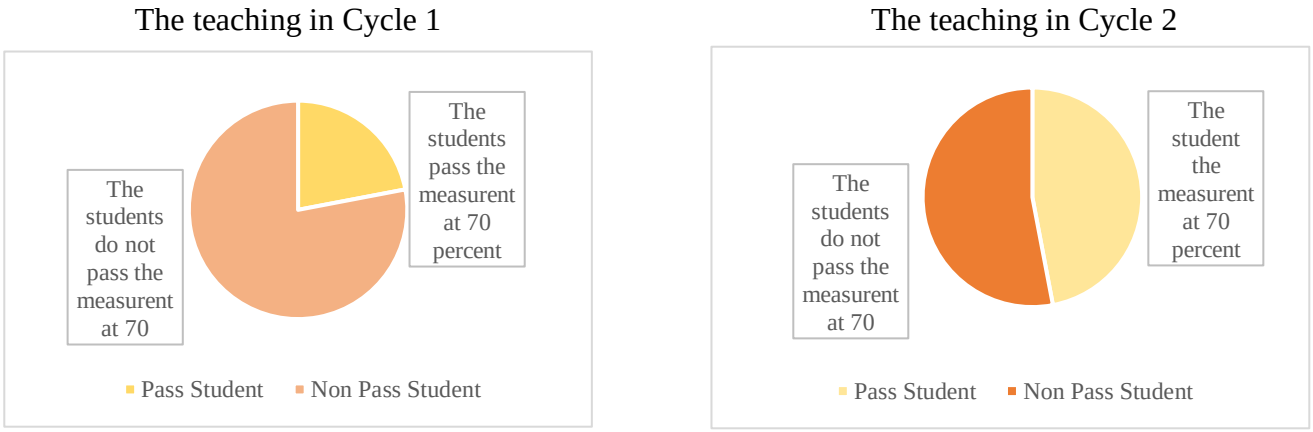

Figure 2 Students' score in each cycle

During the first cycle of instruction, it was found that the students' overall academic achievement score was 7.64 out of a possible 15. This is a percentage of 50.93%, and 8 of the students met the 70% requirement. There were 70 percent of 19 students who passed the criterion of 70 per person, which is a decline from the previous amount. The total academic

achievement score was 10.53 out of a possible score of 15, which represents 70.19 percent. The number of students who passed the criteria decreased.

According to the research on the development of productive thinking abilities of Senior high school level 4 students who received a learning management based on a steam education approach, additional physics subjects on momentum and collisions. The following issues were discussed for discussion:

Teaching cycle 1: Productive thinking for students through STEAM education, it was found that students had an average productivity thinking score of 6.17 out of 12 because most students were interested in new activities and intended to work together, enjoying and teamwork. The teachers arrange various situations to stimulate the students' interest. Understanding of the problem which uses basic knowledge in science, technology, engineering, art and mathematics to design creative work. Beautiful meets the objectives set by the teacher and put to good use from learning management according to the approach of STEAM education tends to develop productive thinking of the students in the target group. But there are still students who still have low scores. The cause may be caused during the event. The students still did not dare to think, dare to do which the minority of students can identify the problem. They need the situation, but still not completely clear and it may be because of the problem situation that the students are not familiar with (Utami & Vioreza, 2021).

Teaching Cycle 2, when improving and developing learning activities according to the steam education approach from teaching Phase 1, it was found that students had an average score of productive thinking equal to 7.82 out of a full score of 12. It can be seen that the student's scores increased because the researcher has adjusted the teaching process in the problem identification stage. The teacher added videos to give students more visualization, practice, analyzing and synthesize data for students to apply to their own work and added rules, regulations, duration spent on activities including providing a suitable place to do activities. Creating an atmosphere of learning for students to the fullest to make students enthusiastic intend to do activities cooperate more with friends in the group (Onsee & Nuangchalerm, 2019). As a result, the students' developmental scores increased from teaching cycle 1 with higher average scores for each step. In part of the stage of active work it because the students still don't choose the right equipment to create the work. There must also be a teacher to guide. But the score has increased from the original (Guzey & Jung, 2021). In terms of the quality of the work, both the teaching phases 1 and 2 had low scores because the students unfamiliar with creating new works this allows the students to create works from what they have seen mostly.

From the discussion of the results of teaching in both phases, it can be seen that the development of productive thinking of the target group of students the development of students' productive thinking. The productivity there is always a way to create a successful work. There are always 3 elements. 1) Planning: there is a plan to create a work in stages and can be implemented. 2) Fluent work: able to choose the right materials and equipment to create the works correctly and appropriately can specify the details of the equipment used including considering the durability of the work-piece for use. 3) Quality of work: work produced by students meets the objectives, is novel in a positive way, is practical and can be applied for the benefit of the students. self and society, from teaching and learning according to the approach of STEAM education, it was found that students learn by themselves.

Additionally, the learning atmosphere is very important to affect the success of learning management, etc. Learning based on STEAM education also makes learners creative and productive individuals, which is an important goal of every country helps to relax forming good work habits, give students the opportunity to research. The teacher is the one who helps, encourages questions and suggests opinions (Auernhammer & Roth, 2022). Students learn more real-life working principles and working principles of engineering. It can be considered that

learning management according to the STEAM education approach is a way to develop students' productive thinking.

The development of the academic achievement in physics found that the students' learning achievement in teaching Phase 1 had an average score of 7.64. Out of the full score of 15, representing 50.93 percent and 8 students passed the criteria of 70 percent. In the second phase of teaching, students had an average academic achievement of 10.36 out of the full score of 15, representing 70.19 percent, and had students pass. The criteria of 70 percent of 19 people in learning management to promote academic achievement. From organizing activities that focus on students searching for knowledge by themselves through that learning activity. At the end of every hour, all students have to solve a problem. It was found that the students were able to complete their assigned tasks and were able to solve some complex problems. But most of the students still do not remember the formulas used in the calculations, including solving mathematical equations is not completely correct. Teachers then help explain the steps to solve problems and summarize various formulas and add equation solving for students to go back and review more content (Prommaboon et al., 2022). Students can connect them to the context of the suitable learning by using group principles to allow peers to help peers in groups increases their learning achievement.

From the research, it can be seen that learning management according to the approach of STEAM education can promote achievement of students and it also fosters the ability to think productively because of achievement scores and student productivity thinking in both phases of teaching has continued to increase as a result of learning management according to the STEAM education approach. That makes students have the courage to think, dare to do, have the ability to search for information, analyze and synthesize information systematically and can understand the problem and find a solution (Nuangchalerm et al., 2020). Students should have leading to the creation of quality and beautiful work pieces, helping to promote cooperation and teamwork.

4. CONCLUSION

The study showed that throughout the first and second cycles, students had scored 51.16% and 65.15% on the productive thinking scale respectively. The learning organization improved the academic performance of the students in each cycle. It is reasonable to infer and consider the potential that STEAM education can support students' intellectual development. It is useful for scientific instruction in schools, but teachers also need to be knowledgeable about how to organize their classes.

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