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INCREASING CREATIVE THINKING OF STUDENTS BY LEARNING ORGANIZATION WITH STEAM EDUCATION

by D. N Ahmad

INCREASING CREATIVE THINKING OF STUDENTS BY LEARNING ORGANIZATION WITH STEAM EDUCATION

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ABSTRACT

The purpose of this research is to analyze the changes in learning between learning before using the STEAM method and learning after using the STEAM method. Where the researchers analyzed the process of student activities in learning, namely in the course of making learning media to determine the ability of students to think creatively in developing the students' knowledge. In obtaining research data, researchers used an assessment score reference instrument, where the final product assessment was assessed by subject lecturers, learning media expert lecturers, and linguistics (language) lecturers. To find out whether there is a change in the ability to think creatively in each learning process before and after learning, the researcher uses a hypothesis test using the t-test. To find out whether there is a change in ability positively, namely the ability to think creatively in each learning process before and after learning, the researcher uses a hypothesis test using the t-test to find out this. It can be seen from the increase in the average learning outcomes before and after with an increase in the difference of 2.26 from the average before using the STEAM method in learning, which is 78.26. The results of the analysis test explain that the learning method using STEAM in learning has a positive impact on learning where students experience a significant average increase before and after being given learning using the STEAM method by providing hands-on experience through the project work process.

INTRODUCTION

The rapid development of science and technology, as well as the implementation of curriculum improvements that have not been comprehensively understood by educators and teachers, thought to have contributed to the problems in the learning process and outcomes. Traditional learning is still used in today's modern era where educators and teachers emphasize the learning process on the ability to remember concepts alone, without providing lifelong learning, and the necessity of learning to be oriented towards future demands also exacerbating the results of the learning process. Education and training for the preparation of prospective teachers as graduates of educational degrees in tertiary institutions must be able to prepare graduates to be ready and reliable in entering the world of work following the specified requirements. To deal with technological changes in the very fast modern era, the learning process for prospective teachers as graduates of educational scholarships combines technology and science in each concentration that is of interest to prospective teachers (students) with the principles of a scientific approach. In addition to this, based on the 2021 Pisa draft states that there must be social sensitivity in addition to thinking technically which puts forward the ability to process existing resources in responding to the fulfillment of the needs of the social community to find solutions to major

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problems, both personally, schools, communities broader or global level by using cognitive abilities, namely critical thinking, analyzing problems and creative thinking to produce an outcome in the form of innovative product.

This is in line with the research problem of Rahmawati et al. (2019) that 21st century learning must collaborate on abilities in the form of communication skills, critical thinking, creative and innovative thinking by combining technology as a tool in every lesson so as to produce innovative findings from project work together. Taylor (2016) & Permanasari et al. (2021) argues that in 21st century learning regarding technology-based learning, art and science provides several important points, namely a. STEAM learning does not conflict with STEM learning, but instead enriches and expands its scope. b. STEAM learning is a curriculum philosophy that empowers science teachers to develop a humanistic vision of 21st century education. c. STEAM learning also provides creative design spaces for teachers in various learning areas to collaborate in developing an integrated curriculum. d. STEAM learning on a simple scale can be designed and implemented by an innovative teacher. e. STEAM educators can draw inspiration from project-based learning. f. STEAM learning engages students in transformative learning, which is based on five ways of interconnected knowledge: cultural knowledge, relational knowledge, critical knowledge, visionary and ethical knowledge, and knowledge in action. Furthermore, the findings of problems in the research discussed by Purnamasari (2020) show that the development or creation of digital literacy in learning needs to be done in inviting students to want to read on a material in learning. According to Zubaidah (2020) individuals with various skills to use technological tools and have literacy (knowledge, media, and the digital era) are expected to have a higher quality and more productive life. In responding to this challenge, the preparation of prospective teachers and educators requires a lesson in making learning media with an approach characterized by the accentuation of the dimensions of observation, reasoning, discovery, validation, and explanation of truth.

Thus the learning process must be carried out guided by the values, principles and criteria of scientific work skills through a series of scientific method work processes. Learning given to students as prospective teachers is given the freedom to gain experience and understanding through learning activities. Student learning activities can be obtained through observation and discovery or experimentation through projects planned in lectures. The lecture project is designed to provide scientific work experience for student teacher candidates. They can also be given the freedom to use various technology and information tools and media, technical performance and also scientific development. Of course, this will increase the thinking and work skills of prospective teacher students when practicing teaching or after graduating from college. One of the efforts that can be done is to provide a lesson that can bring students to an optimal level of creative thinking activity. In line with the opinion of Connor et al. (2015) that an adequate "non-traditional" creative curriculum is needed to produce creative thinking skills. The learning in question is to apply STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning.

STEAM learning emerged as a response to the need to increase student interest and skills in the fields of Science, Technology, Engineering, and Mathematics (STEM) (Quigley et al., 2017). Non-arts educators have struggled with various strategies to introduce art for the purpose of enhancing student creativity and innovative thinking in the STEM curriculum (Rabkin & Hedberg, 2011). STEAM combines "arts" (arts) with STEM learning for the purpose of increasing student engagement, creativity, innovation, problem solving skills, and other cognitive benefits (Liao, 2016), and for enhancing job skills (eg. teamwork, communication, adaptability) necessary for career and economic advancement (Colucci-Gray et al., 2017). Perignat and Katz-Buonincontro (2019) say that STEAM learning develops student creativity or as a means to improve real-world problem solving skills. Perignat and Katz-Buonincontro (2019) state that, although various models are proposed for developing creativity as part of STEAM learning, STEAM educators often have difficulty developing student creativity. It can be concluded that STEAM (Science, Technology, Engineering, and Mathematics) learning is learning that emphasizes the involvement of students in carrying out a series of creativity, innovation, problem-solving skills and work skills in order to produce innovative products in learning.

Wilson and Hawkins (2019) show that STEAM learning makes students appreciate how art and science together use many forms of critical thinking skills, creativity, and imagination when they try to understand real problems. Empirical research has shown that learning in the arts can enhance student creativity, critical thinking, innovation, collaboration, and interpersonal communication skills (NAEA, 2016). Art learning can also improve cognitive skills such

as spatial reasoning, abstract thinking, divergent thinking, self-creativity, openness to experience, and curiosity (Swaminathan & Snellenberg, 2015; Yamin, et al., 2021). Various studies have even linked Nobel laureates to artistic endeavors such as photography, music, performing arts, visual arts, crafts such as carpentry, and creative writing (Root-Bernstein, 2015). The recognized results and benefits from learning the arts served as the inspiration for the STEAM concept, which was introduced in the United States in 2007 (Daugherty, 2013). The concept was introduced to help offset the increasing focus on STEM learning and the decline in art learning in the US over the past decade (Martin et al., 2013). Non-arts educators have struggled with various strategies to introduce art for the purpose of enhancing student creativity and innovative thinking in the STEM curriculum (Rabkin & Hedberg, 2011). Wilson and Hawkins (2020) show that STEAM learning makes students appreciate how art and science together use many forms of critical thinking skills, creativity, and imagination when they try to understand real problems. The STEAM concept explained in various ways, with at least four types of disciplinary integration: transdisciplinary, interdisciplinary, multi-disciplinary, and interdisciplinary (Marshall, 2014). STEAM as a transdisciplinary includes the full integration these various disciplines and their learning is rooted in authentic problems or inquiry (Quigley et al., 2017).

STEAM as an interdisciplinary combines several disciplines under a common theme, but each discipline remains separate (Thuneberg et al., 2017). STEAM as a multidisciplinary includes collaboration between two or more disciplines but not combined (Payton et al., 2017). Finally, cross-disciplinary STEAM focuses on observing one discipline through another scientific perspective, for example: music physics (Gates, 2017). Therefore STEAM learning is needed to improve or accustom students to think creatively in every lesson in order to produce innovative learning products. One of the misconceptions about STEAM learning is that art focuses primarily on finished products, rather than the learning process through thinking, planning, and creating or doing art (LaJevic, 2013). Creative thinking is a thought process that produces a wide variety of possible ideas and ways (Putra, 2012). Selwanus (Rosidi et al., 2013) argues that creativity is one of the human intellectual abilities which is very important because it is included in the ability to solve problems, even often referred to as creative thinking. Torrance (Fardah, 2012) describes creativity as a process of: 1) recognizing problems, information gaps, missing elements, 2) understanding problems, 3) making assumptions and formulating hypotheses, 4) testing hypotheses and evaluating, 5) communicating the results. So it can be concluded that creativity is the ability possessed by students in solving problems to be resolved through observation or analysis activities which consist of several stages, namely analyzing problems or obtaining information about problems, making hypotheses, evaluating and communicating the results of the findings.

Putra (2012) argues that the ability to think creatively includes the ability to: 1) understand problem information, namely showing what is known and what is being asked; 2) solve problems with various answers (fluency); 3) solve problems in one way then another and students provide explanations about the various methods of solving them (flexibility); 4) checking answers with various methods of completion and then creating new, different methods (novelty). Furthermore, Walls (Putra, 2013) states that there are 4 phases of creativity that the creative process goes through: a. preparation phase; b. incubation phase (incubation); c. inspiration phase (illumination); d. realization phase (verification). Creativity can also be developed through a supportive environment where students feel encouraged to think independently, carry out exploration and games, observation and reflection, and asking unusual questions (Plucker et al., 2018). In addition, creativity can also be cultivated through examples and practices (Root Bernstein, 2015). Therefore, teachers should employ creative behavior and build the student's creative independence through feedback that supports and encourages the creative process.

From this opinion, it can be concluded that the stages or phases of creative thinking are: 1. The flexibility and fluency in thinking (understanding problems); 2. Detailed and eloquent thinking (solving problems); and 3. Producing a product of renewal or development of the results and the ability to think through the scientific method. From the discussion of theories study and problems that occur Indonesia's learning today, the researcher wants to analyze the development of students' creative thinking skills as prospective teachers in preparing creative learning media to provide educational information to students who will be taught by these prospective teachers. So that the researchers formulated the problem as follows: "analyzing the development of creative thinking skills in the course of making learning media from the beginning before learning activi-

ties using STEAM to the end of learning by producing learning products that are informative in educating prospective students who will be taught and expected to add literacy to a scientific material".

METHODS

Experimental method is used in conducting this research. There are several activities at the learning stage or lecture, starting from 1) the preparation stage (equating perceptions and the final goal of learning; 2) the stages of developing ideas based on problems that have been found during the preliminary study conducted by students; 3) the stages of discussion between students on the findings and development of ideas in making learning media; and 4) the stages of presentation of the results of the development of learning media and improvements to improve the results of learning media. Where each learning process or lecture is seen, changes in students' creative

thinking patterns in finding solutions to a problem at hand. The learning was by giving project assignments based on the 5 problems stages, then being assessed in the final process of learning. The sample in this research was students of the 5th semester of Indraprasta PGRI University in the 2019/2020 school year, totaling 27 people.

In obtaining research data, assessment score instrument was used, where the final product assessment was assessed by subject lecturers, instructional media experts, and linguistics (language) lecturers as the final score in learning. Before testing the research hypothesis, a simple regression test and linearity in testing the relationship between the variables was carried out. Then to find out whether there was a change in the ability to think creatively in learning before and after learning, the hypothesis test using t-test was done. The reference score of the product final assessment in the form of project assignments in groups and individuals can be seen as follows (Sani, 2016):

Table 1. Assessment Score Instrument for Learning Media Product Test (Group)

No	Criteria	Score Criteria (1-10)	Remedial Notes
	1. Media Rubric		
1	A mix of content and issues		
2	Clarity and regularity in displaying content under the Syllabus and RPP		
3	The combination of colors in conveying a content		
4	The lighting or appearance of the content can grab the user's attention		
5	Learning scenarios and questions in the discussion can be accepted by users		
	Total		
	2. Language (Linguistics) Rubric		
1	The clarity in the use of language		
2	The clarity in the delivery of the material so that it is easy to understand		
3	The content of delivering questions and discussing questions is easy to understand		
4	No discussion is ambiguous or understandable to deliver material content		
5	Continuous learning scenarios in discussion		
	Total		
	Total Score (1 and 2)		

The table is used as a basis for the assessment guide for learning media products being made (in groups) by an expert in the field of media and language, to obtain information on the extent to which students' abilities develop and improve creative thinking skills in presenting learning media products. With this assessment guide, it is hoped that the answers to this research can be aimed.

Table 2. Assessment Score Instrument of Learning Media Product Test (Individual)

No	Criteria	Score (1-10)	Notes
1	Skills in presenting products		
2	Understand the problem of the material		
3	Confidence in revealing material in the form of questions asked		
4	Cohesiveness or cooperation in group		
5	The power of language and individual appearance		
	Total		

Total Score: (Group Score + (Individual Score X 2)) / 2

The assessment guide is made to obtain research information, namely the ability of each student to think creatively in answering problems found in preliminary studies that have been carried out by each individual in a group.

The following steps in conducting research using the STEAM method with project tasks are as follows (Rahmawati et al., 2019):
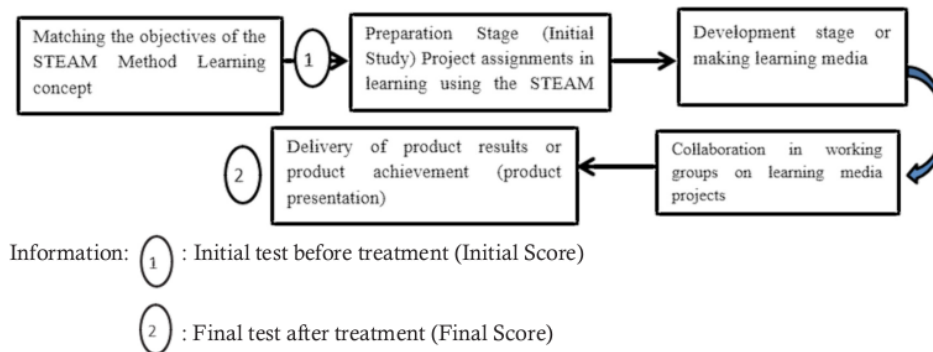

Information: ① : Initial test before treatment (Initial Score)

② : Final test after treatment (Final Score)

Figure 1. Research Stages in Project Work Task Learning Activities

RESULTS AND DISCUSSION

Based on the research that has been done, the following are the results of the research analysis as follows:

1. Results of the Analysis of Creative Thinking Ability Descriptions

The following shows the results of the analysis of the research data description, as follows:

a. Analysis Results from Description before Receiving the STEAM Method

The following are the results of the analysis of the research data description as follows:

Table 3. Analysis of the Description before Receiving the STEAM Method

N		Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Min	Max	Sum
Valid	Missing										
27	0	78.26	0.305	78.00	78	1.583	2.507	5	75	80	2113

b. Analysis Result Description after Receiving STEAM Method

The following are the results of the analysis of the research data description as follows:

Table 4. Analysis of the Description after Receiving the STEAM Method

N		Mean	Std. Error of Mean	Median	Mode	Std. Deviation	Variance	Range	Min	Max	Sum
Valid	Missing										
27	0	80.52	0.308	80.00	80	1.602	2.567	7	78	85	2174

Table 3 and 4 illustrate that there is a change in students' creative thinking patterns. In Table 3 before treatment using the STEAM method, students are still at an average level of 78.26 where at the initial test stage, students are still at the level of not being trained in mastery of visual learning media and still unable to express language that can attract students' interest or is still very simple in creative thinking patterns. In Table 4, the treatment using the STEAM method is carried out. Students experience an increase in their thinking patterns by an average of 80.52 where there is an increase in the difference of 2.26 points. This shows that the STEAM method had an impact on the ability to think creatively, namely producing an innovative learning media product, or it could be said that it develops the existing learning media or producing new products that could be used by teachers or subject teachers.

2. Research Hypothesis Test Results

The following is presented the results of the analysis of the research hypothesis test:

Table 5. Hypothesis Test Analysis Using the STEAM Method

	Method Description	Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Learning Activities Before Giving STEAM - Learning Activities After Giving STEAM	-2.259	0.944	0.182	-2.633	-1.886	-12.432	26	0.000

From the results of the hypothesis analysis test in the table, it shows that: t-count> t-table, namely 12.432> 1.708 and Sig. (2-tailed) indicates that Sig. (2-tailed) count <0.05. Explained that there was a change in students' creative thinking abilities using the STEAM method.

From this analysis, it is explained that the learning method uses the STEAM method, students are invited to continue in improving their creative thinking skills. It can be seen from the increase in the average learning outcomes before and after with an increase in the difference of 2.26 from the average before using the STEAM method in learning, which is 78.26. The difference of the increase in the average learning outcomes shows that the STEAM method is reliable because each student can develop skills in testing or application of knowledge. In this case, the making of learning media based on technology and machines as well as images and language (art) in mathematical analysis, in the form of a scale or a pause between one animated image slide and language with another so that it is easy to understand the delivery of the learning. The analysis of hypothesis testing using the t-test shows that the ability to think creatively using the STEAM method on project assignments has increased by 12,432, greater than the t table of 1.708 by inviting students to participate in the process directly from the preliminary stage (needs analysis, use of appropriate media methods), the stage of making learning media products, the product testing stage until the final stage of product strengthening. In line with the results of research by Rahmawati and Purnomo (2017) that the effect of implementing project assignments on students' creative thinking skills in workshop courses has a high enough response effect to improve creative thinking skills. Moreover, Lestari (2018) stated that learning with the STEAM method with project assignments through the process of scientific and creative processing stages can produce fun, active

and creative learning, especially in online learning so that it can be carried away as learning in the form of skills and life experiences.

In producing a learning media product, students as prospective educators and teachers are invited to conduct an initial study of problems that occur in learning related to learning media, they are invited to analyze learning media that is suitable for learning to produce an output, namely learning media that is making additional literacy in the science that they (students) are currently taking. This is in line with the results of research by Muskania (2017) explaining that the making of learning media developed can equip students with foundational knowledge specifically on digital/ICT literacy. From the learning results in the course of making learning media, students can gain experience through a series of learning processes through project assignments to make learning media that make a creative product that can be used by these students in learning activities and continue to develop learning media in the science they are engaged in so that it becomes literacy digital in their knowledge (students).

CONCLUSION

From the results of the research and discussion, it is explained that the learning method using STEAM in learning has a positive impact on learning where students experience a significant increase in average before and after being given learning using the STEAM method. Furthermore, learning using STEAM can develop creative thinking skills by providing direct experience through the project work process.

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