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EFECTIVENESS OF STEAM-BASED TEACHING MATERIALS TO IMPROVE STUDENTS' CREATIVE THINKING SKILLS

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Abstract

This research was a quantitative study aimed to determine the validity of STEAM-based teaching materials in practicing creative thinking skills of grade 8th junior high school students. The method used test used the pre-experimental One-Group Pretest-Posttest design. This research was conducted on VIIIA grade students of PJ Global Junior High School Malang on July 2019. Based on the research conducted, it was found that the results of the data collection were analyzed using N-gain score. The results of the posttest creative thinking skills test there were 75% students increased their creative thinking skills in moderate category and 25% students in low category based on an average N-Gain score of 0.31. There was an increase in each indicator of creative thinking skills based on the N-gain score that waas equal to 0.24 in the indicators of originality, 0.30 in the flexibility indicator and 0.42 in the fluency indicator. So, the STEAM-based teaching material was feasible to improve students' creative thinking skills.

Keywords: *teaching material, STEAM, creative thinking skills.*

INTRODUCTION

The 21st century demands quality human resources to compete in global competition. The quality of human resources can be improved in several ways, one of which is by improving the quality of education (Muhibbin, 2007). According to Wagner (Zubaidah, 2016) the competencies and skills needed in this 21st century era are expected to have seven skills, namely; (1) critical thinking skills and problem solving; (2) collaboration and leadership; (3) dexterity and adaptability; (4) initiative and entrepreneurship; (5) able to communicate effectively both verbally and in writing; (6) skilled in finding and processing information; and (7) has a high curiosity and imagination. While the US-based Partnership for 21st Century Skills (P21), identified the competencies needed in the 21st century, namely "The 4Cs" are communication, collaboration, critical thinking and creativity.

The ability to think creatively (Putra, et al, 2016) allows students to create new ideas based on prior knowledge to solve problems with a different perspective. The small number of creative people in a country is indicated by the lack of innovation and creation by the community (Putra, et al, 2016). Robert Root-Burnstein's research, Nobel laureate of science, showed that most scientific experts between 1902 and 2005 were adept at not only science but also art (Land, 2013).

Competency Standards and Basic Competencies in the curriculum are directed to provide the skills and expertise of young people in order to survive in the 21st century, one of those is creativity. Existing curriculum actually has supported to develop student creativity. The expected creativity was also accompanied by a strong understanding of concepts. The 2013 Curriculum encourages students to seek knowledge outside the classroom. Students are also required to ask questions more often than not only being asked where the relationship between students and teachers is no longer a teacher and learner but rather a study partner so that students can bring out their respective characteristics. This means that the 2013 curriculum is able to encourage student creativity (Iernawati, 2014).

The survey results of several international institutions show that the development of education in Indonesia has not been satisfactory. This can be seen from the UNESCO report (EFA Report 2007), Indonesia's position in the EFA Development Index (EDI) education index ranking dropped from 58 to 62 from 130 countries. This data showed how low quality of education in Indonesia. Indonesian Human Development Index (Human Development Index) is also still ranked below the other Southeast Asian countries. Indonesia's HDI ranking in 2010 ranked 108th, while in 2011 it dropped to 124th rank. The level of illiteracy in Indonesia is also alarming, which is still around 15.5 million people or 9.07 percent of the total population aged over 15 years. (State Minister of PP RI, 2007).

According to the results of a 2015 Trends in International Mathematics and Science Study (TIMSS)

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survey and the Program for International Student Assessment (PISA) in 2015 the quality of education in Indonesia is still low. The current condition of the ability of Indonesian students in science is ranked 62 out of 69 countries, in mathematics it is ranked 61 out of 69 countries and reading ability is ranked 63 out of 69 countries. (State Minister of Education and Culture RI, 2016)

Based on interviews with PJ Global School Malang IPA teacher, subjects that are considered difficult among the three fields of Natural Sciences are physics. Based on the questionnaire distributed, it was found that only 26% of students in class VIIIA SMP PJ Global School had good levels of creative thinking skills while the other 74% were sufficient. In addition, 11 out of 19 students rarely had different opinions in the discussion and 11 students never submitted different examples about the material while the other 8 students were rare. Besides that 6 out of 19 students always tend to have high curiosity and 8 students often have high curiosity.

Integration of STEAM (Science, Technology, Engineering, Art, Mathematics) means it is very suitable for current educational problems because STEAM cohesiveness is the integration of science and technology that is interpreted through engineering and art and based on mathematical elements. STEAM combines technology, engineering and mathematics to help students see how science works in the real world according to the emphasis on the SLL curriculum. STEAM is also suitable for increasing student creativity because STEAM is a vehicle for creating an environment that triggers creativity, as Campbell said that STEAM helps students find meaningful, creative and innovative ways to expand and connect many disciplines through experiment and imagination. This will help students to apply their learning to success in real life so that STEAM is qualified to increase student creativity (Goo and Haugh, 2015).

STEM education was created to educate student to improve the quality of future youth. Student who have the ability to solve complex problems by using convergent thinking and then applying solutions that are in accordance with the real world use different thoughts. Integrating art into the STEM curriculum provides a pathway for making personal meaning and self-motivation. In addition, the integration of art and science also produces a unique set of skills that can improve the quality of future youth so students can build their own learning through STEAM learning (Land, 2013).

Based on the description according to the experts above, it can be said that SMP PJ Global School Malang still needs to improve students' creative thinking skills. In addition, the results of the questionnaire given to students of class VIIIA SMP PJ Global School Malang showed that students match the STEAM leearning material because the STEAM book contains a lot of new knowledge that they have not known yet because most students already have high curiosity.

According to Rachmawati's research, the results of observations in several schools found that student science learning outcomes tend to decrease and some of the factors that play the most role in this problem are the source books used (Rachmawati, et al, 2017). The student book used at PJ Global School Malang Middle School is the Cambridge curriculum book, Science Checkpoint. In the pressure material, this book does not contain STEAM elements only focused on solid, liquid and gas pressure materials, but there are no examples of applications in the fields of technology and engineering. In addition, this teaching material does not contain elements of art to practice students' creative thinking skills. This means that textbooks are needed to complement due to the lack of STEAM elements in the material of class VIII. Art elements in STEAM are very important because STEAM learning is expected to make students create science products that are useful for human life.

METHOD

This research is a development study using the RnD (Research and Development) model. STEAM-based teaching materials on pressure of matter material includes textbooks, worksheets and lesson plans. The target of this research is the development of teaching material material pressure which is a basic competency 3.8 and tested on 20 students from class VIII SMP PJ Global School Malang. In this study, the type of data obtained is quantitative data using the pre-experimental One-Group Pretest-Posttest design.

Table 1 Pre-experimental One-Group Pretest-Posttest Design

Pretest	Treatment	Posttest
O_1	X	O_2

O_1 = Students' creativity thinking skills before using STEAM-based teaching materials
X = *Treatment* (learning process with STEAM-based teaching materials)
O_2 = Students' creativity thinking skills after using STEAM-based teaching materials

The research instrument used was a pre-test and post-test. Data were collected by test methods that used pre-test and post-test research. Pretest and posttest data were analyzed using the N-Gain score test.

RESULT AND DISCUSSION

Based on research that has been done, the score of creative thinking skills test using STEAM teaching material data is obtained on Table 1, and the improvement score each indicator is obtained on Table 2 and the graph of the improvement creativity test score each indicator is showed on Figure 1.

Table 2. Creative thinking skills test scores

No	Score		N-Gain	Category
	Pretest	Posttest		
1	17,5	42,5	0,30	Moderate
2	38,75	57,5	0,31	Moderate

No	Score		N-Gain	Category
	Pretest	Posttest		
3	60	76,25	0,41	Moderate
4	42,5	70	0,48	Moderate
5	30	41,25	0,16	Low
6	63,75	76,25	0,34	Moderate
7	27,5	36,25	0,12	Low
8	22,5	30	0,10	Low
9	23,75	31,25	0,10	Low
10	18,75	43,75	0,31	Moderate
11	67,5	77,5	0,31	Moderate
12	12,5	42,5	0,34	Moderate
13	5	48,75	0,46	Moderate
14	13,75	40	0,30	Moderate
15	37,5	57,5	0,32	Moderate
16	31,25	37,5	0,09	Low
17	31,25	60	0,42	Moderate
18	45	66,25	0,39	Moderate
19	13,75	43,75	0,35	Moderate
20	45	72,5	0,50	Moderate

Table 3 Percentage of the Students' Creative Thinking Skills Improvement each Indicator

Aspect	Pre (%)	Post (%)	G (%)	<g>	Category
Fluency	37	63,5	26,5	0,42	Moderate
Flexibility	24,75	49,25	24,5	0,30	Moderate
Originality	33,87	48,75	14,9	0,24	Low

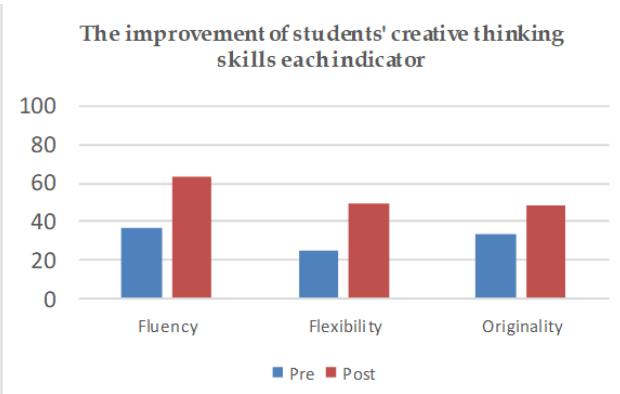

Figure 1 The Improvement of Students' Creative Thinking Skills

The teaching materials include text book, worksheet and lesson plan that each material contain STEAM aspects that is showed on Figure 2.

Figure 2 Teaching Materials

The effectiveness of STEAM teaching materials that are developed in terms of the results of students' pretest and posttest. Pretest was done before students do the learning process using STEAM teaching materials and posttest is done after students do the learning process using STEAM teaching materials that have been developed. Pretest and posttest were conducted to find out the differences in students' creative thinking skills. The results that have been obtained show that STEAM teaching material can train students' creative thinking skills seen from the results obtained by students having increased after the use of STEAM teaching materials in the learning process. This improvement is obtained through activities undertaken by students during learning which help students to improve their creative thinking skills.

The results of the calculation of N-gain scores can be divided into three types of categories, namely low, medium and high (Hake, 1999). Based on Table 1 shows that there are 75% of students got increase in moderate category and another 25% in low category. This is because to obtain maximum results, continuous learning is needed. This is in line with Gelder's study which says that to become an expert in a particular field requires a lot of practice (Gelder, 2005).

As already stated, there are 3 dimensions of the attitude of creative thinking that must be achieved by someone to be said to be creative is the ability to think fluently, the ability to think flexibly, and the ability to think originally. Based on the results obtained, the lowest results are in the ability of original thinking. This is in accordance with the results of Siswono's research that the level of creative thinking emphasizes divergent thinking in the highest order is originality and flexibility and then fluency. Originality is first place because it has the main characteristic in assessing creative thinking products that must be different from before (Siswono, 2017).

The highest increase lies in the ability to think fluently. At first students were still not confident in expressing their ideas but after experiencing STEAM-based learning students began to dare to write down their ideas. The overall N-Gain score can show that the STEAM-based teaching material on the material pressure can train the creative thinking skills of grade 8th students of junior high school. This is in accordance with Istikhomah's research which is obtained the results of N-gain values that increase with the medium category after the STEM-based learning (Istikhomah, 2017). Yunianta said that the small number of people who think

creatively is characterized by the lack of innovation and creation by the community (Putra, et al, 2016). In addition, Robert Root-Burnstein's research, Nobel laureate of science, showed that most scientific geniuses between 1902 and 2005 were adept at not only science but also art (Land, 2013). Thus, students' creative thinking skills must continue to be trained.

The increase in N-gain scores on the creative thinking skills tests that have been carried out is affected by students' responses to learning using this STEAM-based learning material as previously mentioned that the average results of student responses to teaching materials amounted to 91.67% which is appropriate with Clara and friends' research obtained an average student response questionnaire of 92.85% with very high category for STEM-based LKPD can improve students' creative thinking skills with an N-gain score of 0.71 with a high category (Clara et al, 2018). There are several factors that influence creative thinking skills, namely: (1) time, (2) opportunities, (3) encouragement, (4) means, (5) stimulating environment, (6) educator attitudes, (7) giving a lot of knowledge (Tim Pustaka Familia, 2015). Examples of aspects in the questionnaire responses that were shared were (1) the learning activities that I participated in were interesting and fun, (2) I was enthusiastic in participating in the learning process, (3) the use of STEAM teaching materials made me more active through average learning activities the average score was 93.33 with a very feasible category, from these examples it appears that students get encouragement to find out more about the material being taught which can improve students' creative thinking skills.

In addition to the positive student responses, the increased N-gain scores on the tests of creative thinking skills that have been carried out are influenced by the influence of the teacher's activities in conveying learning using STEAM-based teaching materials. The implementation of learning as previously analyzed is always getting a score in each of the opening, core and closing activities above 87.5 which means it is included in the very feasible category. This is consistent with Istikhomah's research that the STEM-based learning that he has done was carried out with an average percentage of teacher activity implementation of 0.90 for all three meetings with very good categories able to increase the value of N-gain on students' creative thinking skills tests (Istikhomah, 2017). There are several factors that influence creative thinking skills, namely: (1) time, (2) opportunities, (3) encouragement, (4) means, (5) stimulating environment, (6) educator attitudes, (7) giving a lot of knowledge (Tim Pustaka Familia, 2015). There are aspects of increasing creative thinking skills in teacher activities that have been carried out namely encouraging students to be able to imagine new ideas (originality), encouraging students to be able to look for other alternatives (flexibility), and encouraging students to be able to explain and do assignments smoothly (fluency) with an average score of 3.85 which is classified as a very feasible category. This teacher activity means it is a stimulating environment so that it can enhance students' creative thinking skills.

The effectiveness of teaching materials is certainly also supported by the validity of STEAM teaching materials that have been validated by 3 validators. This STEAM teaching material has been validated according to the analysis that has been written namely this teaching material gets an average score of 92.16 with a very feasible category for STEAM textbooks, while students worksheets get an average score of 93.92 with very feasible category and lesson plans get an average score of 86.98 also with a very feasible category. This is consistent with the research of Almuharomah who developed the STEM physics module integrated with local wisdom "drum" has been validated with a very feasible category capable of increasing students' creative thinking skills with an N-gain score of 0.92 in the high category (Almuharomah et al, 2019). There are several factors that influence creative thinking skills, namely: (1) time, (2) opportunities, (3) encouragement, (4) means, (5) stimulating environment, (6) educator attitudes, (7) giving a lot of knowledge (Tim Pustaka Familia, 2015). The media used during this learning are STEAM-based teaching materials. In accordance with the factors that influence creative thinking, the means can improve creative thinking skills because this STEAM teaching material has been validated and obtained an average score of 91.02 with a very feasible category so that this triggers an increase in students' creative thinking skills.

CONCLUSION AND SUGGESTION

Conclusion

STEAM-based teaching material was declared appropriate to train creative thinking skills with 75% of students increase their creativity skills in moderate category and 25% of students in low category based on the N-Gain score. There is an increase in each indicator of creative thinking skills based on an N-gain score of 0.24 in the originality indicator, 0.30 in the flexibility indicator and 0.42 in the fluency indicator.

Suggestion

1. For Schools, it should start implementing STEAM-based learning, not only learning in general which tends to be teacher-center.
2. For teachers, students should hold project assignments more often for students. Not only practicum activities but also produce products that can be more useful.
3. For students, they should be more confident with the results of their group work, so they can train their creative thinking
4. For further research, it is necessary to conduct research into the development of STEAM-based teaching materials for other materials, bearing in mind that students' responses to these teaching materials are good.

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