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INCREASING CREATIVE THINKING SKILLS AND UNDERSTANDING OF PHYSICS CONCEPTS THROUGH APPLICATION OF STEM-BASED INQUIRY

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Abstract

This research aimed to improve students' physics creative thinking skills and conceptual understanding of grade 7 of Islamic Junior High School (MTs) Sunan Ampel Nganjuk. This research implemented Classroom Action Research (CAR) with one cycle of two meetings. Each cycle included the stages of planning, implementation, observation, and reflection. The subjects of this study were 17 students of grade 7 of MTs Sunan Ampel Nganjuk First Semester Academic Year 2016/2017. The instruments of data collection in this study were in the form of essay tests (pre-test and post-test) to measure students' creative thinking skills. The results showed the average value of the creative thinking skills of the first cycle and the second cycle which were expressed by the average of N-Gain experienced an increase with the acquisition in the first cycle of 0.6 which was categorized as moderate and increased in the second cycle of 0.7 which was categorized as moderate. In cycle I the highest indicator of creative thinking was fluency, which is equal to 0.76 and the lowest indicator of creative thinking was originality with an N-gain value of 0.34, as well as in the cycle II The highest indicator of creative thinking was the fluency thinking skills which is equal to 0.81 and the lowest creative thinking indicator was the originality with an N-gain value of 0.48. The average value of physics conceptual understanding in the first and second cycles expressed by the average of N-Gain has increased with the acquisition in the first cycle of 0.47 which is categorized as moderate and increased in the second cycle of 0.60 which is categorized as medium. The results showed that the application of STEM-based inquiry can improve the grade 7 students' creative thinking skills and conceptual understanding of MTs Sunan Ampel Nganjuk.

Keywords: *guided inquiry, STEM, creative thinking skills, conceptual understanding*

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INTRODUCTION

The 21st century is a century with rapid technological developments in various countries so students are required to be able to compete globally, therefore the quality of education must be improved (Rohmawati, Widodo, & Agustini, 2018). Education has a role in preparing human resources who are able to think independently, creatively and critically, because education is the basic capital for quality human development. The demands in the current era of globalization are people who are creative and critical. As a result of these demands, the education system must be able to equip students to face life's challenges independently, smartly, rationally and creatively according to 21st century skills which contain three competencies, namely creative thinking, critical thinking, and problem solving (Hasanah & Tsutaoka, 2019; Wong & Cheung, 2018).

In fact, Indonesia's creative thinking skills are still relatively low, as seen from the results of The Global Creativity Index in 2015, Indonesia is ranked 115th out of 139 countries (Florida, Mellander, & King, 2015). For this reason, it is necessary to develop learning in schools that support the improvement of students' creative thinking abilities. This condition also occurs in MTs Sunan Ampel, the majority of students in class VII when taught physics students tend to be passive and have an impact on the low creative thinking skills of students and the low student grade results due to lack of understanding of physical concepts this can be seen cognitive average scores or daily tests of grade 7 students on the previous material 59.8, while the SKBM determined at 75, and the students' creative thinking skills are still low, this is seen in their daily lives when the teacher gives a problem they find it difficult to solve the problem and tend to passively rely solely on answers from books guide.

Science education must be carried out by students (Rohmawati, Widodo, & Agustini, 2018). Science is basically an adaptation of the activities/performance of daily scientists. The work process of these scientists is carried out systematically in accordance with scientific methods. The process of scientific work is known as inquiry processes. The inquiry approach in science education is a necessity. The inquiry process encourages mastery of three skills, namely critical thinking, creative, and problem-solving. In addition, the inquiry approach is divided into several levels according to the assistance given to students during learning. Based on observations, we are interested in applying STEM-based guided inquiry with a view to increasing mastery of creative thinking skills and understanding students' concepts.

METHOD

The research subjects in this study were 17 students of grade 7 of Islamic Junior High School (MTs) Sunan Ampel Nganjuk Academic Year 2016/2017. The research used was classroom action research (CAR) consisting of 2 (two) cycles. The procedures in the first cycle research include:

1. Planning

Researchers compile learning materials including syllabus, lesson plans, student worksheet, and creative thinking skills and concept understanding assessment instruments.

2. Action Implementation

Cycle I was held on 28 and 29 April 2017 with the process of implementing learning using the STEM-based guided inquiry learning model consisting of 5 stages, namely (a) Orientation: the teacher explains the heat then students are guided to make stoves from used materials intended to fish student creativity in making a simple technology; (b) formulating the problem: students formulate the problem based on the observed phenomenon, namely the material provided and the material tools provided; (c) Formulating a hypothesis: students brainstorm each other in forming hypotheses against the formulation of the problem that has been made; (d) Collecting data: by conducting practicum in groups; and (e) Inferring hypotheses: summarizing experiment results.

3. Observation

At the observation, the stage includes observations of the implementation of learning, data on the results of pre-test and post-test creative thinking skills and data on the results of pre-test and post-test understanding of concepts. In this study before the implementation of the learning model carried out the initial test (pre-test) and after the implementation of the learning model carried out the final test (post-test).

4. Reflection

In the reflection activity the deficiencies that appeared in the first cycle were examined. It turned out that in the first cycle the target had not yet reached the target, so that the second cycle was needed to be carried out on 5 and 6 May 2017 consisting of 5 stages, namely: (a) Orientation: the teacher explained about heat transfer; (b) Formulating the problem: students are guided to formulate problems in groups how to design

simple tools by utilizing heat transfer events with solar energy as alternative energy; (c) Formulating hypotheses: students brainstorm each other in groups forming hypotheses; (d) Collecting data: students test designs created by the application of radiation, conduction, and convection and integrate into STEM; and (e) Test the hypothesis: communicate the design to the front of the class and discuss it together.

Research instruments for creative thinking skills and concept understanding which include lesson plans, syllabus, worksheets, and test instruments. The source of the research data is the results of a creative thinking skills test in the form of an essay test that includes four indicators, namely: fluency, flexibility, originality, and elaboration taken from pre-test, post-test, and concept understanding test results. The pre-test and post-test results are processed and analyzed to find out the improvement of students' problem-solving abilities. To find out the increase in learning outcomes between before and after learning from each cycle are classified based on an assessment of the value of the normalized gain calculated by the formula of Hake (1998), namely:

$$N - gain = \frac{(S_{pos}) - (S_{pre})}{(S_{max} - S_{pre})}$$

Where N-gain is normalized gain, S_{max} is the maximum (ideal) score of the initial test and the final test, S_{post} is the final test score, while S_{pre} is the initial test score. High and low normalized gain scores (N-gain) can be classified into three categories, namely: N-gain > 0.7; high category, 0.3 ≤ N-gain ≤ 0.7 medium category; and N-gain <0.3 low category.

RESULT AND DISCUSSION

1. *Result*

In Cycle I, students are guided to make their own stoves for practicum by using used solution cans in order to provoke students' creativity in making a simple technology as shown in Figure 1.

Figure 1. The activity of Making Stove from Cans

In the second cycle of learning, students are guided to make simple tool designs in groups, the results of the design can be seen in Figure 2 below.

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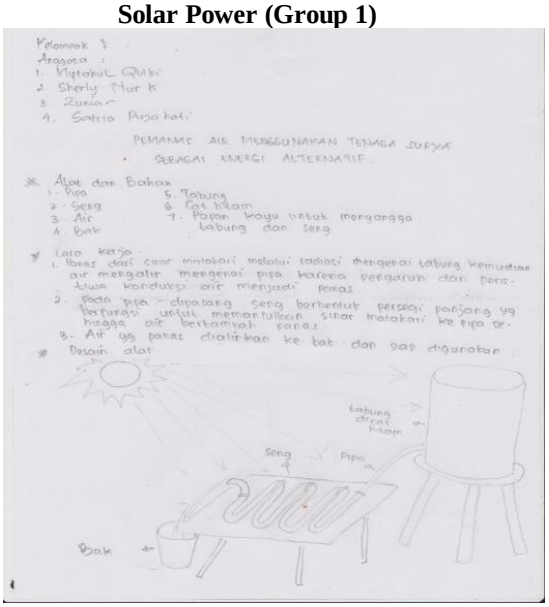
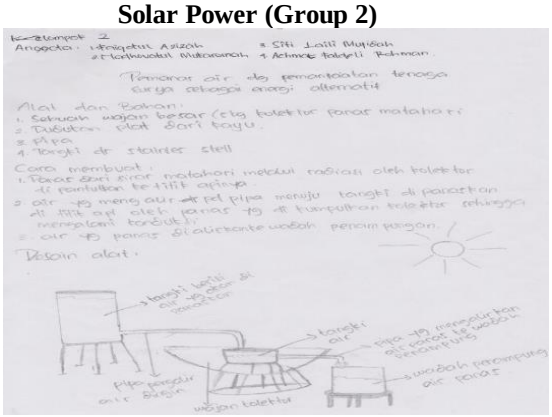
Figure 2. The Water Heater Design Using Solar Power (Group 1)



From the results of group 1 design in Figure 2 showed that STEM-based inquiry learning is able to spur their creativity. In this design, students try to integrate science, which uses sunlight in making simple technology. They are able to utilize simple tools that are around their environment in the form of zinc, pipes, and tubs into a tool that is able to be used to fulfill human life. The use of tools and materials is shown in Figure 3 below.

Figure 3. The Water Heater Design Using Solar Power (Group 2)



From the results of the design that has been made by students in groups (Figure 2 and Figure 3) showed that with STEM learning integrating Science, Technology, Engineering, and Mathematics able to increase student creativity, they are able to develop STEM ideas as constructive young

generation caring and reflective. In addition, STEM learning encourages students to practice in real-world situations. Based on the results of the recapitalization, overall the average value of creative thinking skills in the first cycle and second cycle achieved by students is described in the form of a bar diagram in Figure 4.

Figure 4. The Average Value of Pre-test and Post-test Creative Thinking

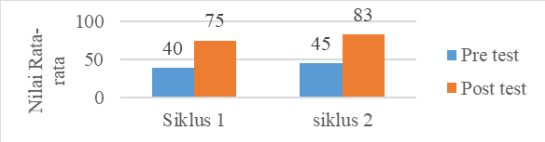


Figure 4 showed the creative thinking skills of students in the first cycle increased from the pre-test average value of 40 to 75 on the average post-test. In cycle II there was also an increase with an average pre-test value of 45 increasing to 83 in the post-test average value. The recapitulation of the results of the increase in N-Gain in cycle I and cycle II illustrated in the form of a bar diagram in Figure 5.

Figure 5. The Results of N-Gain Creative Thinking Skills

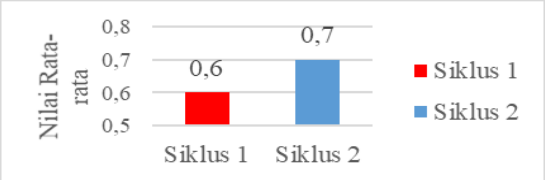


Figure 5 showed that the increase in creative thinking skills after applying STEM-based guided inquiry learning from cycle I and cycle 2 expressed by an average of N-Gain has increased with the acquisition in cycle I of 0.6 which is categorized as medium and in cycle II of 0.7 are categorized as medium. The percentage of the N-gain score of each indicator of Creative Thinking Skills is illustrated in the form of a bar diagram in the following Figure 6.

Figure 6. The N-Gain Results for Creative Thinking per Indicator

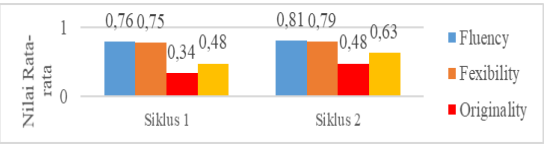


Figure 6 showed the N-gain value of each indicator of students' creative thinking skills is different. The highest creative thinking indicator in both cycles is the fluency indicator and the lowest is the originality indicator.

Based on the recapitulation results, overall the value of N-Gain in Understanding Physics Concepts in cycle I and cycle II achieved by students is depicted in Figure 7.

Figure 7. The N-Gain Results for Understanding Physics Concept Test

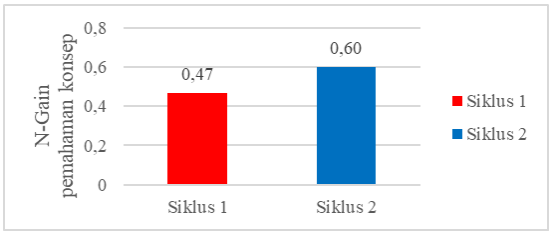


Figure 7 showed that the increase in creative thinking skills after applying STEM-based guided inquiry learning from cycle I and cycle II expressed by an average of N-Gain increased with the acquisition in cycle I of 0.47 which was categorized as moderate and increased in cycle II by 0.60 are categorized as moderate.

2. Discussion

From the results of the research conducted, the results of the students' creative thinking skills test in the first cycle still did not meet the target of 80. In addition, there were still many children whose grades had not yet reached completion, this was due to less optimal learning and discussions in each group had not proceeded smoothly because lack of cooperation and there are still students who make their own fuss so they do not understand the material being studied so that it still needs to be done in cycle II research. After the second cycle treatment, the students' creative thinking skills test and the students' conceptual understanding test have reached the target, which is 80, so the research is sufficient until the second cycle.

In Figure 6 we can see that the N-gain acquisition value of each indicator of students' creative thinking skills varies. In the first cycle, the highest creative thinking indicator is fluency thinking skill, which is 0.76 and the lowest creative thinking indicator is the original thinking skill with an N-gain value of 0.34, as well as in the second cycle indicator The highest creative thinking is also on smooth thinking skills, which is equal to 0.81 and the lowest creative thinking indicator is original thinking skills with an N-gain value of 0.48. That is because the skill of thinking smoothly, problems related to events in daily life and can be obtained from their daily life experiences in the surrounding environment, so

researchers can conclude that these students have extensive knowledge so that they can give ideas smoothly, while the grades the lowest indicator on original thinking skills this is because the originality indicator students are required to give unusual answers, others from others, which are rarely given by most people while the majority of students answer with the same answer. According to Piaget entitled the intellectual development of junior high school students is at the concrete operational and formal operational stages so that their abstract thinking is still not good (Ibda, 2015).

The research that is relevant to this research is the research conducted by Suparman & Husen (2015) to get the same results, that is an indicator of high creative thinking skills is smooth thinking skills, while the lowest value on the indicators of original thinking skills. Overall, the N-gain average grade of creative thinking skills and understanding of physics concepts is in the medium category. Based on the results of the analysis proves that the application of STEM-based guided inquiry can improve the creative thinking skills of grade 7 students of MTs Sunan Ampel Nganjuk. The research that is relevant to this research is research conducted by Mayasari, Kadarohman, Rusdiana, & Kaniawati (2016), namely by making creative products by integrating STEM knowledge that can influence the level of student creativity, creatively influenced by STEM knowledge that can support student creativity by integrating knowledge, skills and ability to solve everyday problems.

From the test results of understanding the physics concepts of cycle I and cycle II, the results obtained in the first cycle obtained the highest score found in the indicator "Describe with your own sense of heat" that is by obtaining an average score of 16, this is due to the indicator containing questions about understanding heat is the basis of the material learned so that each student must remember the notion of heat and be able to answer the question correctly. While the lowest score is on the indicator "Complete the amount of heat needed to raise the temperature of the substance with the equation $Q = m.c.\Delta T$, $Q = m.U$, and $Q = m.L$" with an average score of 12, this is because the majority of students prefer to memorize material rather than memorizing equations.

In the second cycle the highest score is found on the indicator "Students can describe the types of heat transfer" that is by obtaining an average score of 15, this is due to the material types of heat transfer they have ever gotten when they were grade 6 (elementary school level) so that students memorized and able to work on the problems of the types of heat transfer and their understanding. The lowest score is found on the indicator "Students can describe the concept of the Black principle" with the acquisition of an average score of 10, this is because the indicator contains questions about the equation and the majority of students do not memorize the Black principle equation.

The lowest average score of physics concept understanding in cycle I and II is found in the problem which is the application of the formula. Based on observations of learning difficulties because they are weak in calculations, i.e. the calculation errors made by students can occur because they read wrong signs or numbers, or because they do not write numbers clearly enough in the right place. Some common mistakes children make are lack of understanding of symbols, place values, calculations, incorrect use of processes, and unreadable writing. Based on the results of tests in cycles I and II it appears that the application of STEM-based inquiry learning helps students understand concepts.

CONCLUSION

Based on the research conducted, it can be concluded that the average value of creative thinking skills in cycle I and cycle II expressed by an average of N-Gain has increased with the acquisition in cycle I of 0.6 which is categorized as moderate and in cycle II of 0.7 which is categorized as medium. The N-gain acquisition value of each indicator of students' creative thinking skills is different, in the first cycle and the second cycle the highest indicator of creative thinking is fluency and the lowest indicator of creative thinking is originality. The average value of understanding the concepts of Physics cycle I and cycle II expressed by an average of N-Gain has increased with the acquisition in the first cycle of 0.47 which is categorized as moderate and increased in the second cycle of 0.60 which is categorized as moderate. Based on the results of the analysis proves that the application of STEM-based guided inquiry can improve creative thinking skills and understanding physics concepts of grade 7 students of MTs Sunan Ampel Nganjuk.

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