Implementation of STEAM Education to Improve Mastery Concept

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Abstract. Science Technology Engineering, Art, Mathematics (STEAM) is an integration of art into Science Technology Engineering, Mathematics (STEM). Connecting art to science makes learning more effective and innovative. This study aims to determine the increase in mastery of the concept of high school students after the application of STEAM education in learning with the theme of Water and Us. The research method used is one group Pretest-posttest design with students of class VII (n = 37) junior high school. The instrument used in the form of question of mastery of concepts in the form of multiple choices amounted to 20 questions and observation sheet of learning implementation. The results of the study show that there is an increase in conceptualization on the theme of Water and Us which is categorized as medium (<g>=0, 46) after the application of the STEAM approach. The conclusion obtained that by applying STEAM approach in learning can improve the mastery of concept.

1. Introduction

Science Technology Engineering Mathematics (STEM) is a generic curriculum that works on the education of Science, Technology, Engineering, and Mathematics in learning that utilizes interdisciplinary knowledge and an applicative approach in problem solving. Over the past few decades, STEM education has focused on improving science and mathematics as an integrated discipline [1] [2][3] and emphasize on technology [4][5]. STEM is often taught apart from art, creativity, and design [5]. Education STEM as an approach that explores teaching and learning between two or more subjects in school [2]. STEM education is an effort to incorporate several disciplines; technologies, techniques, and mathematics into one class, unit, or lesson based on the relationship between subject and real-world problems [6].

Science Technology Engineering Art Mathematics (STEAM) is an extension of Science Technology Engineering Mathematics (STEM), by including the Art element which is a positive, rich, and powerful element in civilization and in many ways can take a decisive position. Art can be applied Fine Art (sculpture, graphics, craft, painting), communication (literature, advertising, multimedia, social media, etc.), performances (film, drama, theater, music, dance, etc.), lifestyle (fashion, interior design, product design, etc.), and character (culture, behavior, attitude, etc.). The integration of art in learning can be done by means of learners communicate the idea of science through visual information in which contains the concept of science combined with images, texts, and others [7]. Learners can also create a drama to describe a concept of science. Science Technology Engineering Art Mathematics (STEAM) is an approach in the learning process that combines science, technology,
engineering, mathematics, and the arts in the learning process. Objective of STEAM approach in learning not only helps for teaching science concepts, but can also make learners think and work with art and science, inspire learners to become more different, and become creative thinkers across disciplines. The most remarkable thinkers in the field of science or mathematics are strongly influenced by interests, and knowledge of, Music, art and more [8] [9] [10] [11]. The linkage between science and art is very important whether it is dedicated to discovering truth or beauty than if it were science and art separately [12]. STEAM can be a very important paradigm for teaching and learning science more creatively and artistically. STEAM approach is expected to make learners at ease, so they can more easily understand the concept to be conveyed and can apply it in everyday life and can explore the potential in them. Through STEAM, learners not only reinforce their learning in all disciplines, but through the discipline learners also get the opportunity to explore and make connections between art, music, science, and others. [Henriksen 2014. STEAM's learning is required by Indonesian students as an effort to train their talents and talents to face the problems of the 21st century [13] [14] [15] [16] [7].

The purpose of this research is to apply STEAM approach to learning with Theme Water and Us to know the improvement of mastery of science concept of junior high school students. The theme is a combination of several basic competencies in science and mathematics subjects in class VII junior high school. The theme of water and us are chosen because it combines some basic competencies into an interesting theme that can make time more effective, and can facilitate learners in understanding a material or concept. In addition, water is a very important component in our lives. But on the other hand, water can also be a disaster for us if not properly guarded. Therefore, it is hoped that with the theme of water and us, learners can understand where the water comes from, and how to use the right water and keep the water so as not to bring disaster that can cause harm. By studying the theme of water and us learners can know the concept of science that exist in everyday phenomenon making it easier for them to learn.

2. Methods
The theme of water and us are delivered with STEAM approach that integrates science, technology, engineering, art, and math in the learning process. The application of science is applied when explaining the natural phenomenon of water. Application of technology is done when students apply a technology product that is using a simple tool to measure rainfall. Application of engineering is done when the students make a product design to cope with water pollution. Implementation of art is used to explain the phenomenon of water by including elements such as writing or drawing and instilling awareness of the importance of water for life. The application of mathematics is applied to measure rainfall and to design a safe mask and goggles used during the dry season.

Research method in this research is pre-experimental with one group Pretest-posttest research design. Water and Us theme is divided into four sub themes namely the properties of water, water cycle, water pollution and seasons. STEAM's approach is implemented in three meetings with a total of 8 hours of lessons. Before applying the STEAM approach, learners are given a test in regard to concept mastery (pre-test) to see learners’ ability of early mastery of the concept before the STEAM approach is applied. After the application of STEAM, the students were given a concept of (post-test) to see the ability of mastering the concept after the application of STEAM. During the learning processes, there are three observers to observe the implementation of learning at each meeting. The implementation of STEAM learning is assessed through an observation sheet filled by the observer at each meeting. Each learning aspect that was successful was given a score of 1 and if it was not successful was given a score of 0. The total results of the scores obtained will then be converted into a percentage form to see the percentage of STEAM learning practice. Mastery of concepts is measured using Concept Mastery Tests on theme water and us given before and after the application of the STEAM approach. Mastery of the concept test is made in the form of multiple choice questions of 20. Each correct answer will be given a score of 1 and each wrong answer will be given a score of 0. The
results of the pre-test and post-test obtained by the learners are then used to measure the rate of improvement Mastery of the concept is processed based on a normalized gain calculation [17].

Participants of this study were seventh-grade students from one of several junior high schools in North Bandung of West Java, Indonesia, with total 37 students in 2016/2017 academic year selected by random sampling technique. North Bandung area is a water absorption region, the area is a hill area, and located at the foot of Mount Tangkuban Parahu.

3. Results and discussion
Learning on this research using STEAM (Science Technology Engineering Art Mathematics) approach with material on "Water and Us" theme which is a combination of some basic competencies of science class VII subjects. At the first meeting all learning activities that have been planned can be done entirely. While in the second meeting amounted to 89.7% of the activities performed and at the third meeting of 91.7% of the activities performed. There are several activities at the second and third meetings that are not executed due to inappropriate timing. At the second meeting the unavailable activities were the teacher's activities to provide correction and reinforcement of the material on water pollution as well as the learners did not have the opportunity to conclude the learning outcomes they had gained in the second meeting on the topic of water pollution. This is due to the time spent in the learner collecting information and communicating the learning outcomes for too long beyond the planned time. Activities that did not happen at the second meeting were then diverted at the third meeting. At the third meeting the preliminary activities at the beginning of the lesson begin with the unfinished activity at the second meeting. After providing corrections and reinforcement on the topic of water pollution and allowing learners to conclude the learning outcomes at the second meeting on the topic of water pollution, then the activity continues with the topics studied at the third meeting on the seasons. At the third meeting there were also some unfinished activities. The activity is a reinforcement of the material that has been studied on the topic of the season as well as the learners have no chance to conclude the learning outcomes. Although in the second and third meetings there are unfinished activities, but seen from the percentage of all STEAM implementation activities on the theme water and us for three meetings it can be said that all the learning stages are included in the percentage of good category.

The mastery of this concept refers to Bloom's taxonomy C1 up to C4 i.e remembering, understanding, applying and analyzing. Concept mastery improvement is measured by the normalized average gain of the pretest and posttest results. Here is a recapitulation of the normalized average gain calculation results shown on Table 1.

| Test   | N  | Ideal Score | Min Score | Max Score | Average Score | Gain Score | <g>  | Category |
|--------|----|-------------|-----------|-----------|---------------|------------|------|----------|
| Pretest| 37 | 20          | 3         | 13        | 8.2           | 5.4        | 0.46 | Medium   |
| Posttest|     | 20          | 8         | 18        | 13.6          |            |      |          |

There is an increase in average score on posttest results compared with pretest results. The magnitude of this increase can be seen from the normalized gain results of <g> = 0.46 in the medium category [17]. The result shows that the application of STEAM on the theme water and us can improve the mastery of the concepts of learners. Learners are motivated or interested to follow the learning process seriously and the topic presented is very beneficial for their lives. STEAM can improve learners' motivation [7]. By the emergence of learning motivation there will be encouragement for learners to learn. Curiosity and want to explore a wider subject can be a factor that encourages a person to learn.

Increased mastery of the concept of 37 learners as research participants have increased with different categories. 16% or 6 students have increased the mastery of the concept that includes high category, 68% or 25 students including medium category and 16% or 6 students including low
category. The causes of 6 people are included in the low category in the improvement of the concept mastery in general is the inaccuracy in reading the problem and the lack of attention during the learning process is underway. Lack of attention during the learning process can have an effect. Attention that is given intensively at the time of learning activities can make learning achievement becomes higher. Although the results of mastery improvement of the concept on medium category, but the activity and motivation of students arise during the learning. High skill of the students during learning is less related to result of improvement of conceptual mastery [18].

Improved mastery of concepts can be seen from the topics in the questions. The results of improving conceptualization are viewed from topics in the question of mastering the concept theme of water and us are shown on Table 2.

**Table 2.** Data Result Improved Mastery Concept Based on Topics in Concept Test Mastery Concept Theme of Water and Us

| No | Topic                        | Number of Problems | Pretest Score | Pretest % | Posttest Score | Posttest % | <g> | Category |
|----|------------------------------|--------------------|---------------|-----------|----------------|------------|-----|----------|
| 1  | The characteristics of water | 2                  | 0.65          | 32        | 1.2            | 58         | 0.38| Medium   |
| 2  | Water cycle                  | 4                  | 0.78          | 20        | 1.9            | 49         | 0.36| Medium   |
| 3  | Water pollution              | 9                  | 4.05          | 45        | 6.35           | 71         | 0.46| Medium   |
| 4  | Seasons                      | 5                  | 2.73          | 55        | 4.11           | 80         | 0.61| Medium   |

Based on Table 2 shows that the improvement of conceptualization on the topics of water properties, water cycle, water pollution and seasons are included in the medium category. Water cycle topics have the lowest normalized gain values compared to the other three topics. Students are having difficulties in calculating the volume of rainfall in a certain area by using the ratio of area and volume. During the study, the reinforcement of topics at the time of measurement of rainfall by the researchers is less detailed because of time constraints, so that only a few participants have the opportunity to ask when there is less understood on the topic. In addition the ability of logical thinking mathematically of junior high students is low enough that students have difficulty in using mathematical equations and operating mathematical equations [19].

Based on the results obtained, the application of STEAM approach in learning can be an aid in teaching about the concept of science, make learners interested, motivated [20,21,22] curiously aroused so that learners are more creative in thinking [8,9,10,11]. Through STEAM approach, learners are more easily understanding the concept and applying the theme of Water and Us in daily life and can also explore their inner potential. Learners get the chance to explore and make connections between art, science, math, and technology. In addition to assisting in understanding the material and motivation, STEAM's approach can awaken learners in terms of thinking, creativity, and character [8,23].

### 4. Conclusion

The application of the STEAM approach on "water and us" theme can improve the concept mastery of learners. As many as 16% of students included in the high category, 68% of students included in the medium category and 16% of students included in low categories. Overall, approach STEAM on the water and us theme can improve the concept mastery of learners based on the results indicated by normalized gain score of <g> = 0.46 and categorized in the medium category.

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