The Effect of science learning bases-STEM assisted by augmented reality toward scientific attitudes and science outcomes

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Abstract. STEM-based science learning assisted by augmented reality can answer 21st-century education challenges by characterizing the interdisciplinary approach of the four fields of study. 21st-century learning requires students to be literate in science, technology literacy, creativity, and have a good scientific attitude. STEM-based science learning aided by augmented reality is a learning approach that can develop scientific attitudes and improve the learning outcomes of the basic concept science of students. This research was conducted to find out the effectiveness of the application of STEM-based science learning models assisted by augmented reality on scientific attitudes and science of PGSD students’ learning outcomes of STKIP Santo Paulus Ruteng. The research design used was quasi-experimental in the form of a non-equivalent pre-post control group design. Based on the results of the effectiveness test, it is known that the experimental class n-gain value is greater than the control class. It can be concluded that STEM-based science learning can develop scientific attitudes and improve students’ science learning outcomes.

1. Introduction

Mastering science and technology is an important key to facing challenges in the future. Education in the current era which is characterized by the development of science and technology in the field of life in society is an aspect of determining the speed and success of mastery of science [1]. The increasingly fierce competition requires qualified and professional human resources in various fields of life.

The quality and meaningful learning process of science are inseparable from the way teachers apply and use the approaches, strategies, and learning methods in learning science. Professional science teachers are expected to deliver students to navigate the world of science and technology in this competitive era. Professional science teachers in elementary schools are inseparable from the provision of learning skills obtained from higher education, namely Elementary School Teacher Education (PGSD). However, it should be recognized the results in science education at Indonesia are still low. So far, the learning science at schools emphasizes the nature of science as a product rather than science as a scientific attitude and process. The low-quality Program results for International Student Assessment survey. Three years Indonesia is always the lowest; in 2009 ranked 60th from 65 countries, in 2012 ranked 64th from 65 countries, and in 2015 ranked 63th from 72 countries in the world [2]

Other indicators of the low level of science education also took place at PGSD STKIP Santo Paulus Ruteng where researchers taught. The results of the semester exam results for the basic science concept courses
at STKIP PGSD for three consecutive years have not achieved satisfactory results. The 2015/2016 school year amounted to 65.4, 2016/2017 school year amounted to 62.4, and the 2017/2018 school year only reached an average of 71.4 (Results of US Data Report of Manggarai district, NTT Province, 2018).

The low learning outcomes of science caused by the learning process carried out are still centered on the teacher or lecturer, so that outcomes only cover pieces of knowledge, have not achieved attitudes and skills competencies. The form of the questions given still includes Middle Order Thinking Skills (MOTS) and Lower Order Thinking Skills (LOTS), so students are not familiar with high-level thinking.

The low level of science outcomes and scientific attitude is certainly a result of the unsuccessful science learning process being implemented. Many factors influence it, namely, the low quality and quantity of human resources (teachers and teaching staff), the quality and quantity of educational infrastructure, and the quality of the teaching and learning process which are prominent factors [3]. Therefore, research and development of various models and learning approaches are needed that state students to learn actively, creatively and innovatively, especially at PGSD students. They as the candidates of educators in elementary school are learning agents.

One of the dominant factors that are thought to affect the quality of science education is low, especially the learning outcomes of science and scientific attitudes is that the learning approach applied by educators is not appropriate. The learning approach used so far tends to apply a conventional approach. Science taught only achieves the nature of science as a product and ignores the nature of science as a process and scientific attitude. Science teaching material should be oriented towards "science for life" and "science for scientist" with a balanced portion. Science education is expected not only to be at school but also in the community [4]. The implementation of science learning is less linked and matched with social issues and technological developments that exist in local, regional, and national communities.

Related to the increasing quality of science education in Indonesia, there are many efforts by the government, namely improving teaching staff through education and training, procurement of facilities and infrastructure in the laboratory, library, and curriculum. In higher education, the Indonesian National Qualifications Framework (KKNI) based curriculum has been applied. The KKNI aims at improving the quality of graduates and as a statement of the quality of Indonesian human resources whose qualification gaps are expressed in learning outcomes. Learning outcomes in the course are tailored to the learning needs of students which is an accumulation of student learning outcomes and organizing study material or lecture material, and assessment. Achievement of learning basic concepts of science for students is expected to achieve attitudes, skills, and mastery of knowledge.

STEM a combination of interconnection scientific disciplines in STEM can not be separated from science learning. [5] states the benefits of STEM make able solve problems, be innovative, independent, logical thinkers, and critical. STEM-based learning can build creativity and environmental literacy that are indispensable for facing the 21st century. STEM that is applied in learning has advantages for students, namely, 1) able to ask questions and define problems. 2) design problem-solving processes. 3) able to conduct an investigation. 4) can mathematics. 5) able to information technology computers, 6) build involved evidence-based [3].

Furthermore, the results of [6-10]'s research shows that STEM-based learning can develop prospective teacher pedagogical competencies, achieve affective and cognitive domains in science learning, increase student interest, learning takes place happily without pressure, and students can solve problems in learning science.

The application of STEM can be supported by the use of learning media in the learning process will affective. It is suspected that the media that supports STEM is Mobile Augmented Reality (MAR). MAR as a type of virtual laboratory may build STEM skills. [11] states that MAR as a form of combining visualization between the real and virtual worlds will with computer-generated elements, in 2 dimensions and text. This means that MAR learning media is a real-world display both directly and indirectly coupled with computer-generated information and combining.

Assumed STEM-based assisted by MAR in learning science will develop students’ that controlled by perception. The students' initial knowledge contributes to determining the high and low level.
Apperception an internal factor that influences scientific attitudes and science outcomes. It needs to controlled so that the pure influence of STEM implementation is helped by MAR in science learning on scientific attitudes.

Purpose find out: 1) science took STEM-based learning assisted by MAR and students who followed conventional learning in learning science. 2) the differences in scientific attitude, between students who took STEM-based learning assisted by MAR and students who followed conventional learning in learning science. 3) the differences in learning outcomes and scientific attitudes simultaneously, between students who took STEM-based learning assisted by MAR and students who followed conventional learning in learning science.

2. Methods

Non-equivalent control group design with a covariable design presented in Figure 1. below.

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O  X  Y2
O  Y1
O  O
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**Figure 1.** Experimental procedure for non-equivalent control group design

Description: O = pretest & posttest; X1 = STEM learning model; Y1 = science learning outcomes; Y2 = scientific attitude to science.

The population of this study is all first-year PGSD students at STKIP Santo Paulus Ruteng population is 416 in 9 classes. There are many obstacles during conducting this project. Therefore, this study was carried out on several samples in this population.

The selection of classes as a research sample used random sampling techniques. This was divided into 2 experimental classes and 2 control classes. Before determining the sample, an equality test was conducted on the 10 class members of the population. Class equality is seen from the equality of achievement in learning the basic concepts of science. The equality test was carried out by a t-test at after conducting the were determined.

Results valid analysis of scientific attitude questionnaire instruments and the item tests were very valid (1.0> 0.74) because of the CVR-hit> CVR-table with the CVR-table = 0.74. Analysis of construct validity of the scientific attitude questionnaire and science questions with trials on the first level PGSD students at STKIP Citra Bhakti Ngada produced valid data (0.85> 0.30). Data analysis in this research using MANOVA

3. Results and Discussion

3.1. Scored Description of Scientific Attitudes of Students who Followed STEM-Based Science Learning Assisted MAR

The process of learning science through STEM-based science learning used augmented reality learning media through development with the help of Vuforia SDK and using unity. The appearance of the heart structure which was used as a marker in augmented reality as follows.
Figure 2. a) Heart markers, b) Display augmented reality, and c) heart image in vuforia

Data on scientific attitudes of students participating in science learning with STEM-based learning assisted by MAR in each dimension are categorized as in Table 1.

Table 1. Categories of Scores of Scientific Attitudes of Students Who Follow STEM-Based Science Learning Assisted MAR

| Dimension                                | Experimental Classes | Control Classes |
|------------------------------------------|----------------------|-----------------|
|                                          | Average | Category | Average | Category |
| Curiosity                                | 136     | Very Good | 125     | Good     |
| Respect for data                         | 137     | Very Good | 124     | Good     |
| Desire accepts uncertainty/doubt         | 136     | Very Good | 84      | Middle   |
| Critical thinking                        | 134     | Good      | 75      | Middle   |
| Perseverance                             | 135     | Very Good | 118     | Good     |
| Creative and discovery                   | 134     | Good      | 73      | Middle   |
| Open-minded                              | 135     | Very Good | 120     | Good     |
| Sensitive to the environment and non-life| 137     | Very Good | 88      | Middle   |
| Cooperative                              | 138     | Very Good | 130     | Good     |

Table 1. shows that the scientific attitude score of students participating in STEM-based science learning is MAR-assisted on dimensions: 1) curiosity, 2) respect for data, 3) hesitation, 4) critical thinking, 5) perseverance, 6) creative and discovery, 7) open-minded, 8) sensitivity to the environment, 9) cooperative are in a very good category and the scientific attitude score of students who take conventional learning are in the good category.

The following is shown in the diagram of the average of take STEM-based learning assisted by MAR with conventional learning.
Figure 3. Differences in scientific attitude questionnaire scores between students who take STEM-based science learning assisted by MAR and students who take conventional learning

Description:  A = Curiosity; B = Respect for data; C = Desire to accept uncertainty / doubt; D = critical thinking; E = Perseverance; F = Creative and discovery; G = Open minded; H = Sensitivity to the environment and non-life; I = Cooperative.

3.2. Scored Description of Learning Outcomes of Science Students Who Followed STEM Based Learning Assisted by MAR and Students who Followed Conventional Learning
Science learning outcomes data of students participating in STEM-based science learning assisted by MAR and conventional learning in the cognitive process applied conceptual knowledge and cognitive processes to analyze procedural knowledge as shown in Table 2.

Table 2. Categories of Pretest and Posttest Results Score of Student Science Learning Outcomes the STEM Based Learning is assisted by MAR and Learning

| Cognitive process               | Experimental Classes | Control Classes |
|---------------------------------|---------------------|-----------------|
|                                 | Pre-test | Posttest | N-Gain | Category | Pre-test | Posttest | N-Gain | Category |
| Applying conceptual knowledge   | 60       | 80       | 20     | Very Good | 50       | 70       | 20     | Good     |
| Analyzing procedural knowledge  | 50       | 80       | 30     | Very Good | 40       | 60       | 20     | Sufficient |

Table 2. shows that the score of STEM-based assisted by MAR in the cognitive process applying conceptual knowledge and analyzing procedural knowledge are in the very good category. There are control classes in a good and sufficient category.

The results of the test-of-subjects’ effects on the differences in science learning outcomes between students taking STEM-based science learning assisted by MAR and students who took conventional learning showed a value of $F = 134.875$ with a significant number of 0.001 and a difference in mean = 61.034. This significant number is below the specified level of significance, thus $H_0$ is rejected. This means science between STEM-based science assisted by MAR.

The test of the effects participating in based science assisted MAR taking conventional, showed a value of $F = 89.132$ with a significant number of 0.001 and a mean difference $= 15.744$. This significant number is below the specified level of significance, thus $H_0$ is rejected. This means take STEM-based science learning assisted by MAR.
Multivariate test on science students took STEM-based science learning assisted by MAR and students who took conventional learning showed a significance value of 0.001 with Lambda's F-Wilks value = 45.8. This significant number is below the specified level of significance, thus H₀ is rejected. This means that scientific attitudes simultaneous take STEM-based science learning assisted by MAR.

Testing the second hypothesis through test-of-subjects’ effects on the STEM-based science assisted by MAR followed showed significant number is below the specified significance level. This means the results science learning between STEM-based science assisted by MAR and students who take conventional learning.

About aligning activities with the division of involvement of STEM-based learning activities in middle school students, collectively found that hands-on activities and active learning involve STEM are very effective because STEM is contextual, it means that it is very relevant to the real world that creates a high interest in doing activities [12]. The results of this study also [5], regarding the application integrated improve literacy in terms gender, showing an increase in different classes between male and female are insignificant. In the aspect of science attitude, the female class differed significantly from the male class. The overall response of the students showed that almost all students expressed pleasure in learning the STEM PjBL and gained a very memorable experience following the stages of learning, giving rise to motivation and getting interested in learning. The test-of-subjects’ effects of scientific attitudes between students participating in STEM-based science learning assisted by MAR followed showed the significance number was below the specified significance level, thus H₀ is rejected. This means took STEM-based science learning assisted by MAR.

Further analysis of description scientific attitudes in each dimension for students who took part in science learning with STEM-based learning assisted by MAR is in the very good category. The description of the scientific attitude for students participating in science learning with conventional learning is in good and sufficient category.

The results of this study support the results of research carried out by [13] research on attitude majoring curriculum on demonstrating that students' scientific attitudes are very high in terms of curiosity, predictability, honesty, and openness. The greatly affects the scientific attitude of students [13]. The also [14] about the teaching attitude of science and towards showing significantly that students' attitudes, meaning environments and teacher attitudes science effect attitudes.

The results of testing the third hypothesis through multivariate tests about science students took STEM-based science learning assisted by MAR and show that significant number is below the specified significance level, thus H₀ is rejected. This means that scientific attitudes simultaneous took STEM-based science learning assisted by MAR.

This study prove science learning with STEM-based learning assisted by MAR has a positive effect on scientific attitudes and student science learning outcomes.

4. Conclusion
From the results of the hypotheses test as described above can be concluded that STEM-based learning assisted by MAR in learning science influences the results of learning science and scientific attitudes.

In more detail, this can be concluded as follows. (1) The results of STEM-based science learning assisted by MAR are superior compared to the control class, (2) Difference in who take based science assisted by MAR, (3) The results of scientific attitudes simultaneously between students who take STEM-based science learning assisted by MAR.

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