Learning based virtual laboratory media to increase cognitive ability of students at SMPN 1 Manokwari

by Sri Wahyu Widyaningsih

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Abstract. This study was a Classroom Action Research (CAR), which aims to improve the cognitive abilities of students of SMPN 1 Manokwari after application of virtual laboratory media-based learning in science subjects static electricity material. The CAR model used was the Kemmis and Mc Taggart models. The research was carried out in two cycles, each consisting of 4 stages, namely planning, implementing actions, observations, and reflections. The instruments used were cognitive ability tests given after learning in each cycle, learning achievement observation sheets, and student activity observation sheets filled by observers during learning. Data analysis techniques used were descriptive analysis techniques to describe students' cognitive abilities. The results showed that there was an increase in cognitive abilities of students in cycle 1, namely 59.5 ± SD 11.2 and cycle 2, namely 73.5 ± SD 13.8. Therefore, virtual laboratory media-based learning can be applied to static electricity material at SMPN 1 Manokwari to develop students' cognitive abilities.

1. Introduction

The development of Information, Communication, and Technology (ICT) have penetrated in various sectors, one of which is in the education sector. The use of ICT in learning can be in the form of material delivery directly by the teacher or direct involvement of students in using ICT as a learning resource [1,2]. ICT in its development can be in the form of interactive simulations that allow students to conduct experiments like in a real laboratory or known as virtual laboratory programs [3,4]. Virtual laboratories can simulate various abstract phenomena, especially in science subjects, especially physics such as static electricity. Students can easily understand the subject matter so that their cognitive abilities are expected to be developed through the use of virtual laboratory media [5,6].

Based on observations at SMPN 1 Manokwari, it was found that the cognitive abilities of students were still lacking. This can be seen from their lack of activity in answering questions given by the teacher during learning. Students will be seen actively responding to questions given by the teacher if they understand well the subject matter delivered [7,8]. Students will more easily understand the subject matter if they do and find out for themselves a concept that is studied [9]. Experiment activities in the laboratory are important because students can find and practice their concepts [10]. Students can conduct experiments related to the subject matter being studied if existing facilities and infrastructure support the implementation of practical activities [11]. In fact, in school, it is still constrained by the limited facilities and infrastructure to support the experimental activities. One solution that can be done is to

apply to learn in the form of virtual laboratory media so students can find their own concepts through virtual experiments [12,13].

2. Methods

This study was a Classroom Action Research (CAR), which aims to improve the cognitive abilities of students of SMPN 1 Manokwari after application of virtual laboratory media-based learning in science subjects static electricity material. The CAR model used was the Kemmis and Mc Taggart models [14]. The research was carried out in two cycles, each consisting of 4 stages, namely planning, implementing actions, observations, and reflections. The instruments used were cognitive ability tests given after learning in each cycle, learning achievement observation sheets, and student activity observation sheets filled by observers during learning. Data analysis techniques used are descriptive analysis techniques to describe students' cognitive abilities. Categorizing assessment of students' cognitive abilities as shown in Table 1 [15].

Table 1. Criteria for interpretation of the score

Interval	Predicate
0-25	Very less
26-50	less
51-75	Good
76-100	Very good

3. Results and Discussion

The results of the initial observations of learning, namely before the implementation of virtual laboratory media, it was seen that students had difficulty in understanding the subject matter, especially in the abstract material. Teachers provide detailed explanations related to the subject matter that was studied from beginning to end so that the activities of students were not visible during the learning activities. Teachers need to innovate in learning so students can understand well the subject matter learned. One solution that can be done was through the use of virtual laboratory media in learning. The virtual laboratory media applied in science learning at SMPN 1 Manokwari was adapted from the PhET media (https://phet.colorado.edu/). PhET media provides simulations in the form of virtual laboratories so that students can experiment like real labs [16,17]. Virtual experiments can provide students with a good understanding of natural science materials [18,19]. The appearance of the virtual laboratory media used in learning as shown in Figure 1.

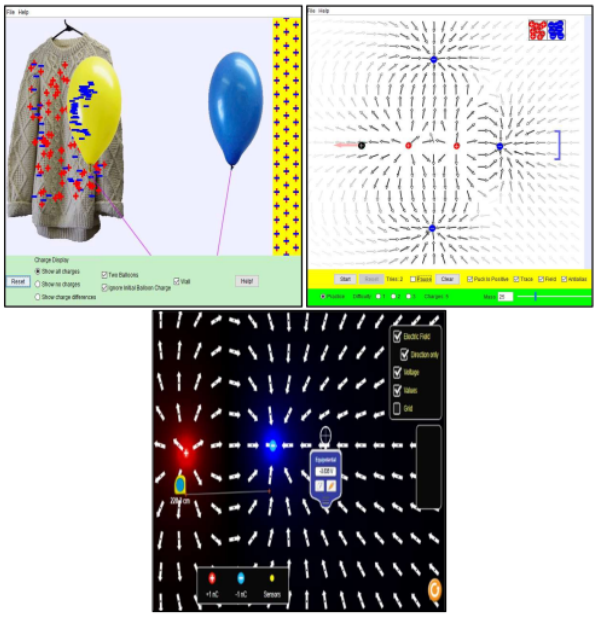

Figure 1. Display of a virtual laboratory on static electricity materials

Figure 1 shows the appearance of virtual laboratory media on static electricity. Static electricity material is one of the concepts of physical material that is abstract so that students usually have difficulty in observing the phenomena that occur. The use of virtual laboratories was very helpful for students in understanding concepts and increasing enthusiasm in the learning process. At the first meeting, which was about electric charges, a virtual experiment was shown in the form of a balloon rubbed on a shirt. After experimenting, students can conclude that the charge that can move was a negative charge (electron). Virtual laboratories can simulate abstract science materials so that students' cognitive abilities can be developed [4,20]. Assessment of students' cognitive abilities as shown in Table 2.

Table 2. Cognitive learning outcomes of students

Interval Class	Cycle 1		Cycle 2		Category
	Frequency	Percentage	Frequency	Percentage	
0-25	0	0.0	0	0.0	Very less
26-50	5	16.7	1	3.3	Less
51-75	22	73.3	16	53.3	Good
76-100	3	10.0	13	43.3	Very good
Total	30	100	30	100	
Average	59.5 ± SD 11.2		73.5 ± SD 13.8		
Min	39		50		
Max	78		100		

Table 1 shows that there was an increase in students' cognitive abilities in each cycle. In cycle 1 it was obtained an average value of 59.5 ± SD 11.2 and increased in cycle 2 which was 73.5 ± SD 13.8. The cognitive abilities of students can also be seen based on the distribution of values at each class interval. In the first cycle most of the students (73.3%) had a score of 51-75 (good), and in cycle 2 there was an increase in the number of students who obtained grades at 76-100 intervals (very good) that is 43.3% of the previous only 10.0%. The cognitive abilities of students were seen based on the results of their work in answering the questions given. Students can answer correctly each question given as in Figure 2 dan 3.

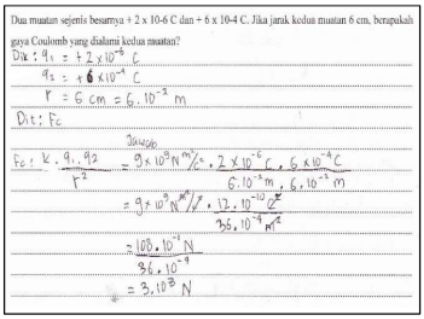

Figure 2. Learners can answer questions correctly according to the equation.

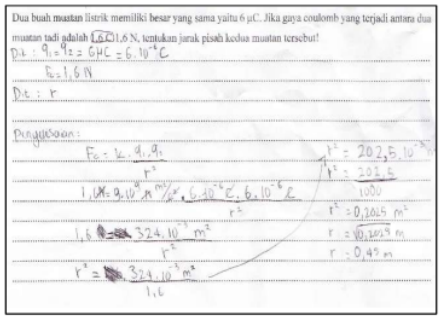

Figure 3. Students can transform their knowledge on other issues.

Figure 2 shows that students can identify every amount known in the problem. Students can also calculate correctly and determine the appropriate unit of magnitude based on the equation. In Figure 3 shows that students can formulate equations to determine the magnitude of the others, they can transform their knowledge to answer new problems. Students can answer correctly every problem related to the topic of the material being studied because they are used to learning and simulating various quantities through virtual laboratory media. Virtual laboratory media can simulate various quantities so that students can easily understand the relationships of various quantities [21]. Virtual laboratories are also interactive so that students can simulate and conduct their own experiments to understand the concept of the material being studied [22,23].

The results of the assessment of observations of the implementation of learning by observers found that at each stage of learning it was carried out and done well. In the preliminary stage, the teacher explains the competencies that must be achieved and motivates students to be more enthusiastic in participating in learning activities. At the core stage of learning, the teacher demonstrates the available virtual laboratory media material to expand and know the extent of the students' initial understanding. Teachers also provide worksheets to all students to be done individually even though the data collection process was carried out in groups. The collection of virtual experimental data in groups is expected to develop good cooperation and interaction between students to improve their cognitive abilities [24]. At the next stage, students present their work in front of the class. Students discuss each other related to the material being studied. It is hoped that through the discussion process during learning can increase students' understanding which ultimately increases their cognitive abilities [25]. The measurement of cognitive abilities of students is then assessed individually to determine their respective ability levels.

The results of observations of student activities show that most students were active from the beginning to the end of learning. At the beginning of learning using virtual laboratory media students enthusiastically pay attention and follow learning. At the core activity, students pay attention to the teacher's explanation, answer the questions given, study and spell out assignments given through the use of virtual laboratory media. Students actively discuss with group friends, work on questions given and

can answer questions during class discussion. At the end of learning, students can deduce the subject matter being studied. The use of virtual laboratory media in learning encourages students' curiosity, so they continue to try to learn the material and in the end can understand well the subject matter learned. The virtual laboratory media used consists of interesting display simulations and animations so that students do not feel bored in learning. The attractive appearance of virtual laboratory media can increase students' learning motivation because they can learn while playing [26,27].

4. Conclusion

Based on the results it can be concluded that the use of virtual laboratory media can improve the cognitive abilities of students at SMPN 1 Manokwari. In cycle 1 there were 73.3% of students having good grades and 10.0% in very good categories. The cognitive abilities of students increased in cycle 2, namely 53.3% of students had good grades, and 43.3% were very good. The results of observations of students' learning activities in the classroom also showed that most students were active in learning. Therefore, it can be concluded that the use of virtual laboratory media in learning can improve students' cognitive abilities

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7