Application of e-handout with Schoology-based PhET simulations to improve students' visual representation ability on optical material

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Abstract. This research is pre-experimental and has a purpose to improve students' visual representation ability through the application of e-handouts with schoology-based PhET simulations on optical material. Sub material taken is lenses and optical devices. One group pre-test post-test was designed in this research with samples were selected by the technique of cluster random sampling. XI MIA 3 class was sample as the implementation class and XI MIA 5 was sample as a modeling class at SMA Negeri 1 Sleman, Yogyakarta. The samples consist of 55 students. The essay test of eligibility results by expert judgment was used in this research. The research result is the application of e-handouts with Schoology-based PhET simulations can improve students' visual representation ability and include in the medium category for both classes.
Keyword: *e-handout, PheT simulation, Schoology, visual representation ability, optical material*

1. Introduction

Teaching material is one of the important things in the learning process. Teaching materials are made based on the needs and characters of the subject matter. Making teaching materials is part of the responsibilities of teachers in schools. One of the printed teaching materials is handout [1]. In the handout, there is a variety of literature that is relevant to basic competencies and subject matter. Handouts are used as supporting explanations of information or subjects by the teacher to students [2].

In physics, there are optical materials that require interesting visualizations for students. For optical materials, ray diagrams and equations should be considered more in learning [3]. Therefore, the teacher needs a tool or media to explain the material so that it is easily understood by students [4]. But there is no handout with visualization of optical material that is presented interestingly based on current learning.

Current learning in 21st-century learning. 21st-century learning emphasizes the use of technology in its implementation [5] such as the internet. The development of internet technology gave rise to various new applications as learning tools known as e-learning [6].

E-learning is an effort to provide learning in class and learning material on new media that develops the era of learning management systems (LMS) [7]. The material in learning can be visualized in more dynamic and interactive sizes and shapes, so students in the learning process will be more motivated and more involved [8]. LMS that can be utilized in the learning process includes Schoology, Learnboos, Edmodo, and Moodle [9]. In schoology, the teacher is given absolute authority in processing and

managing classroom activities. Students cannot be carelessly doing activities outside of learning activities because the teacher can eject students from class or temporarily disable them. With proper classroom arrangements and the provision of considerable and interesting teaching materials, students will be enthusiastic and responsible for every learning in Schoology [8].

In addition to teaching materials, to help students understand the subject matter can use a PhET simulation. PhET simulation is a virtual physics laboratory [10] which has the advantage of being safer and easier to use at any time in several activities compared to physical laboratories [11], [12]. In the PhET simulation, there are various physical materials such as optics about the light diagram. By using a PhET simulation, students can demonstrate their ability to actively apply scientific activities that are compiling investigations, conducting repeated trials, making predictions, making observations, explaining the results of investigations, and evaluating the investigations of other students [13].

An optical material, understanding the lens ray diagram is important so that it is easily applied to optical devices such as the eye, camera, loop, or microscope. The ability to understand ray diagrams can be demonstrated through visual representation ability. The visual representation is the ability to understand images, diagrams, tables, or graphs. With visual representation, students' understanding of abstract concepts can become real [14]. The visual representation ability is the ability to interpret images and identify data with operational forms of restating information or data from a representation to the representation of graphs, tables or diagrams and solve problems by using visual representations [15]. Therefore, to assist students in learning optics better, ways are needed to encourage the connection of student representations in learning and to test the ability of the student representation in using light diagrams [3].

This research has the purpose to find out the improvement of visual representation ability from the student by applying the e-handout application with schoology-based PhET simulations. The e-handout has provided lesson material, sample questions, exercise questions and student worksheet that can facilitate students because students no longer need to take notes in the learning process.

2. Research method

This section explains the research methods used.

2.1. The research type

The research type is pre-experimental with the design in figure 1. The place of this research in SMA Negeri 1 Sleman, Yogyakarta and done in April 2019.

O_1	X	O_2

Figure 1. The design of research.

2.2. The research population and sample

The population is all of classes XI students in SMA Negeri 1 Sleman, Yogyakarta in the 2018/2019 academic year. Cluster random sampling techniques were used to taken the samples of this research and obtained class XI MIA 3 with a total of 28 students as the implementation class and class XI MIA 5 with a total of 27 students as a modeling class. Implementation class is a class conducted by researchers and modeling class is a class conducted by a physics teacher at SMA Negeri 1 Sleman, Yogyakarta.

2.3. The research variables

The research variables consist of dependent and independent variables. First, the dependent variable in this research is the students' visual representation ability. And the second, the independent variable in this research is e-handout with schoology-based PhET simulation.

2.4. The data collection and instruments techniques

The data collection techniques are measurement. Data collection is done through pre-test and post-test used an essay test about lenses and optical devices. The instrument consists of 5 questions to both pre-test and post-test. The instrument has two indicators are interpreting images to numbers one to three and identifying data to numbers four to five. The questions of the test used are shown in figures 2 and 3.

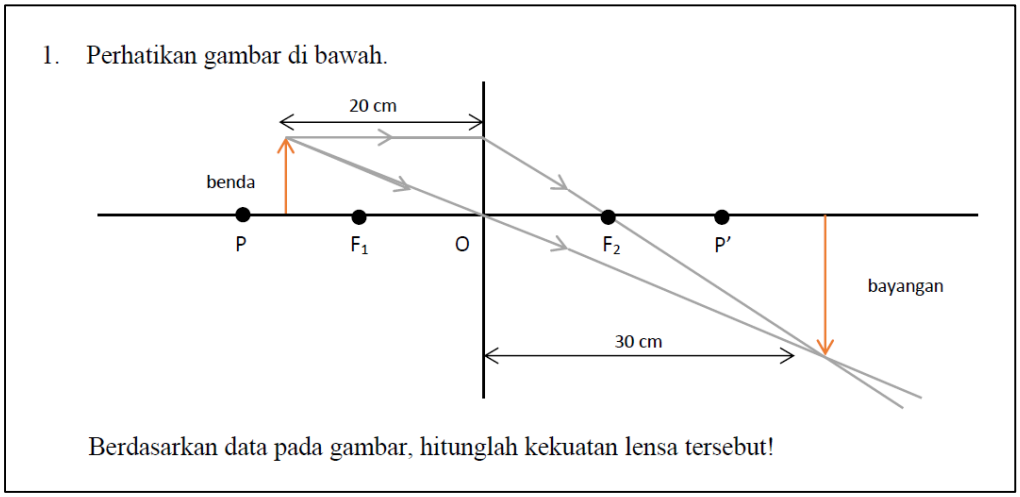

Figure 2. Number 1 of question about lenses and optical devices.

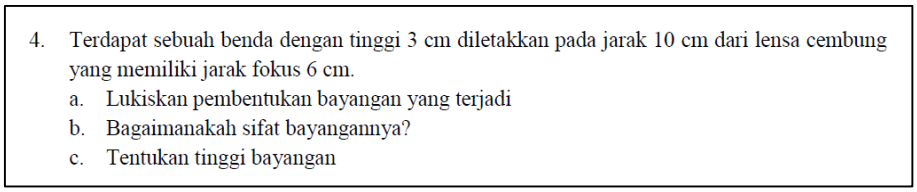

Figure 3. Number 4 of question about lenses and optical devices.

2.5. The techniques of data analysis

Analysis of the data was performed by using the results from both of the tests and then the results were analyzed by the equation of N-gain [16] where shown in equation 1. Analysis of data was performed to see the improvement in students' visual representation ability before and after the application of e-handouts with schoology-based PhET simulations. The analysis has three categories where interpreted in table 1.

$$g = \frac{\bar{X}_{posttest} - \bar{X}_{pretest}}{\bar{X}_{max} - \bar{X}_{pretest}} \quad (1)$$

Information, g is the value of n-gain, $\bar{X}_{posttest}$ is the post-test mean value, $\bar{X}_{pretest}$ is the pre-test mean value and $\bar{X}_{max}$ is the mean of maximum value.

Table 1. Interpretation of n-gain value.

The value	Interpretation
N-gain < 0.3	Low
0.7 > N-gain ≥ 0.3	Medium
N-gain ≥ 0.7	High

3. Results and Discussion

This section explains the results and discussion of the research.

3.1. The result of research

The test of visual representation ability about lenses and optical devices was tested for eligibility using expert judgment. Test results show that the test instrument is feasible to use.

The results of this research are divided into two parts, namely the results of research from the implementation class (XI MIA 3) conducted by researchers and modeling class (XI MIA 5) conducted by physics teachers.

3.1.1. The implementation class. The result of students' visual representation test for implementation class is shown in table 2 and the result of the analysis is shown in table 3.

Table 2. The test results of the implementation class.

Result	Pre-test	Post-test
The highest of score	77.5	97.5
The lowest of score	0	0
The average of score	19.9	47.5
Increase of average score	27.6	

Table 3. The analysis result of the implementation class.

The highest of value	The lowest of value	The average of value
0.89	-0.39	0.34

There is an increase in students' visual representation ability based on the average value in table 3. With this, the improvement of students' visual representation ability is categorized into the medium category. The level of the category of increasing students' visual representation ability is shown in table 4 and the improvement of students' visual representation ability on each indicator of the test is shown in figure 4.

Table 4. Categories for improving students' visual representation ability.

Level of categories	Total of students
High	4
Medium	11
Low	13

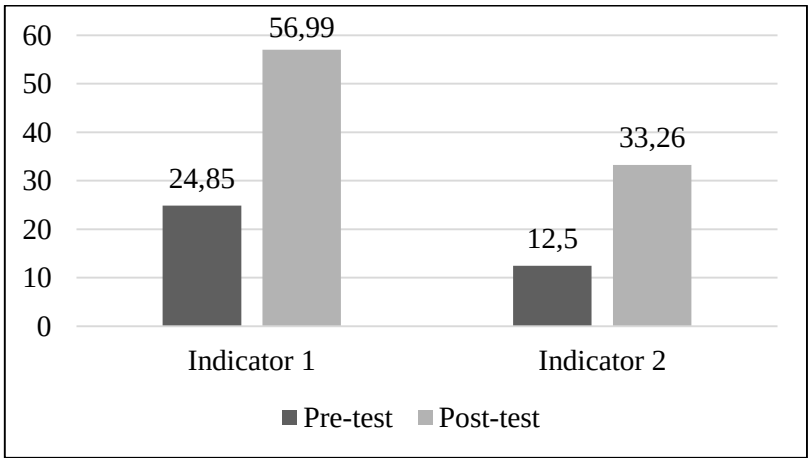

Figure 4. Graph of improved indicators of visual representation ability of implementation class.

3.1.2. The modeling class. The result of students' visual representation test for modeling class is shown in table 5 and the result of the analysis is shown in table 6.

Table 5. The test result of the modeling class.

Result	Pre-test	Post-test
The highest score	60	80
The lowest score	0	25
The average of score	16.0	43.3
Increase of average score	27.3	

Table 6. The analysis result of the modeling class.

The highest value	The lowest value	The average value
0.67	-0.07	0.31

There is an increase in students' visual representation ability based on the average value in table 6. With this, the improvement of students' visual representation ability is categorized into the medium category. The level of the category of increasing students' visual representation ability is shown in table 7 and the improvement of students' visual representation ability on each indicator of the test is shown in figure 5.

Table 7. Categories for improving students' visual representation abilities.

The level of categories	Total of students
High	0
Medium	15
Low	12

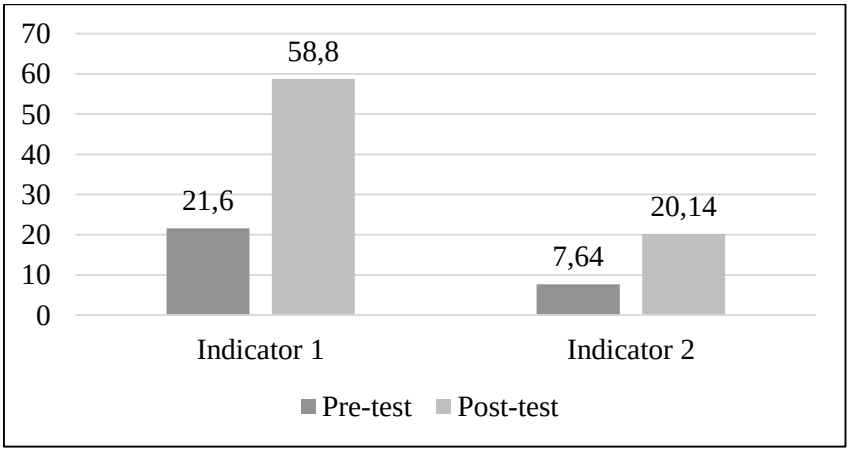

Figure 5. Graph of improved indicators of visual representation ability of modeling class.

3.2 The discussion of research

The average pre-test score of students' visual representation ability showed that both in the implementation and modeling classes had not yet reached the KKM value. This can be caused by many factors. One factor is that students lack an understanding of optical material, especially in lenses and optical devices. This lack can be a given effect on students' visual representation ability. Furthermore, the result shows that there is an increase in visual representation ability. The increase is due to the implementation of e-handouts with school-based PhET simulation which in the process is done through a problem-based learning model. This is supported by research [17] that an increase in students' thinking

abilities on optical material uses online simulations through problem-based learning models. . By using PhET simulation will improve students' thinking skills [18]. Students will more easily understand the material delivered by the teacher with an increase in thinking skills.

The learning process in both classes is carried out by directing students into several study groups using online schoology classes. Physics learning based on schoology become an attractive supplement, easy to use and effective in learning [19]. In the schoology class, e-handouts, PhET simulations, and LKPD were provided. A handout will guide the teacher in regular and clear learning. A handout will also help students not to take too many notes, because many notes will take up too much time [1]. Researchers or teachers provide problems using videos on students then guide student investigations to clarify the results of investigations and answer problems that students have written before on the LKPD. Clarification is done by paying attention to the theory that has been provided in the subject matter in the e-handout. This investigation uses a PhET simulation as shown in figure 6.

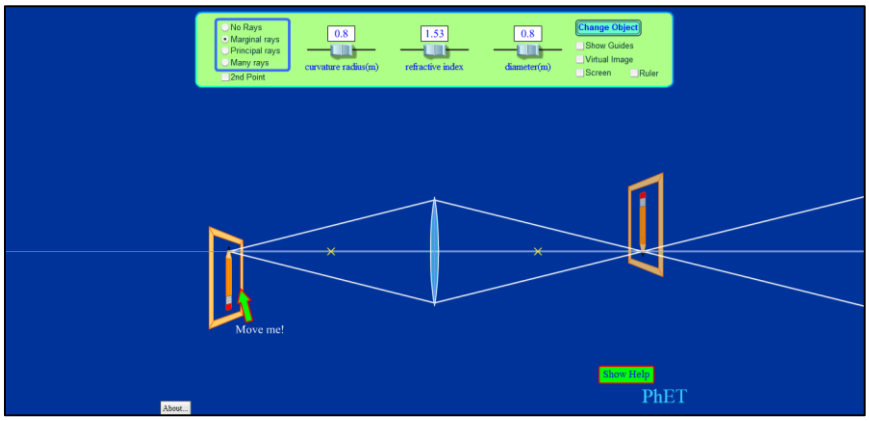

Figure 6. The investigation with PhET simulation.

PhET simulations provide visualization of rays on the lens to reduce the abstract level of optical material based on the result of data analysis. Visual explanation can be given by the phenomena modeled on PhET Simulation to students [20]. The visual representation abilities on the first indicator are presented pictures to clarify the problem then facilitate its resolution experienced a fairly high increase than the second indicator which presents data or information from verbal representations or images into image representations in both classes. The improvement of the first indicator shows that students can solve problems based on the pictures provided, while the second indicator shows that students are not trained enough to draw a lens beam diagram especially if applied to an optical device such as a loop. Besides, students are less able to distinguish between the magnification of the angle with the magnification of objective and ocular lenses.

There is a limitation in research that access to the use of online schoology classes is not good enough even though the signal amplifier has been used especially in the PhET simulation which requires a strong network. Besides, teacher guidance is still needed by students even though students have been facilitated by using e-handouts in schoology classes. Therefore, the learning process in the implementation and modeling class requires quite a long time.

Nonetheless, an increase (n-gain) of 0.34 and 0.31 for modeling and implementation classes shows that there is an increase in the category of applying e-handouts with schoology-based PhET simulations of students' visual representation ability on optical material.

4. Conclusion

The research purpose to show the improvement of visual representation ability through the application of e-handouts with schoology-based PhET simulations on optical material. The conclusion that can be drawn is the application of e-handouts with schoology-based PhET simulations can improve the ability of visual representation of students with moderate categories in both implementation and modeling

classes. For further research, time management and internet networks need to be considered so that they do not become obstacles in the learning process.

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