The Effect of The Use of Harmonic Movement PhET Interactive Simulation in Online Learning Process on Mastering the Concept of High School Students

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Abstract. This research aimed to determine the effect of using the PhET Interactive Simulation in the online learning to the conceptual mastery ability of high school students. The method used in this research was an experimental method with the one group pretest posttest research design. The research sample was selected using purposive sampling technique from a population of the Science and Mathematics Group Students of Public High School (SMAN) 1, Jakarta. The research instrument used was an objective test of students' mastery of concepts that had been tested for validity, reliability, difficulty level, and distinguishing power. Based on the results of data processing, the average of pretest and posttest scores were 47.42 and 73.55, respectively, and the N-gain of 0.51 with the medium category. The analysis result shown that count (10.909) was larger than table (2.042) which indicated that the null hypothesis (H0) was rejected and the alternative hypothesis (HA) was accepted. Meanwhile, the strength of the effect of using the PhET simulation in the Online Learning Process to Mastery the Concept of Harmonic Motion for High School Students on a numeric scale was categorized high with an effect size value of 1.79. Thus, it can be concluded that the PhET simulation can be applied to mastery of the physics concept of Harmonic Motion in the online learning process of high school students.

1. Introduction

The outbreak of coronavirus diseases 2019 (covid-19) in Indonesia provide a restriction on various public activities including teaching and learning process at school. As an alternative, an online learning process is applied by utilizing internet technology and other supporting learning facilities. The online learning is a learning process that is carried out when students and teachers do not physically meet at school [1]. However, this online learning rises up a problem that hampered, especially to the learning activities for example, likes physics that use experimental approach through practicum in the laboratory.

Meanwhile, based on a preliminary survey to the students conducted in the SMAN 1 Jakarta, as many as 80% of respondents said that they found difficult to understand the concept of physics during the online learning process. This condition will certainly have an impact on the lack of students' mastery of physics concepts. Whereas, the students are required to master physics concepts in order to be able to develop their knowledge and abilities in solving a problem. Therefore, effective learning strategies need to be applied in helping students to master the concepts of physics. One of them, this can be done by using an alternative learning medium which can practically be utilized by students in mastering the physics concept they are learning. One of the learning media...
that can be used to meet the needs and interests of students for mastering those physics concepts is the PhET (Physics Education Technology) Interactive Simulation that is containing virtual experiment developed by the University of Colorado, Boulder, USA [2]. As known that PhET Interactive Simulations are designed to be flexible to improve the way of teaching and learning physics; so it can be used as a teaching demonstration, laboratory, or homework activity. Thus, the students can gain significant learning experiences that are synthesized into three big themes: learning physics is fun, learning physics is real, and learning physics is simple and easy [3].

Many relevant research results for example by [4, 5, 6, 7] generally, they agree that the use of PhET Interactive Simulation has a positive impact on learning achievements or outcomes of the students in physics. Unfortunately, the use of PhET Interaction Simulation has not been integrated with online learning physics at SMA N 1 Jakarta. About 80% of students stated that their physics teacher had never used the PhET Interactive Simulation in the online learning process at their school. Based on this description as described above, this research was conducted to analyze the effect of the PhET Interactive Simulation when was applied in the online learning process to the students' concept mastery ability, especially, in the Harmonic Motion. The results of this study are expected to benefit physics teachers, especially at SMA N 1 with an idea how to select an alternative learning media PhET Interactive Simulation in order to support their online teaching and learning process for improving students' conceptual mastery abilities. Furthermore, by using this PhET Interactive Simulation, it is expected that can improve understanding of physics, material that is conceptually difficult for students.

2. Concept Mastery
Mastery of concepts is defined as the ability to understand, comprehend, apply, classify, generalize, synthesize, and conclude objects so that they are not only a simple understanding about objects, but can also to describe it [8]. According to Dahar quoted by [8], mastery of concepts is the result of a learning process which is indicated by the ability of students to analyze and explain concepts in their own language. One of the indicators of students in understanding what they have learned can help students in solving problems, not only in learning at school, but also in everyday life [10]. Whereas, Arends quoted by [9] stated that mastery of concepts can help students in constructing an understanding of previously owned concepts in achieving mastery of the concepts being studied.

It is very important and prioritized in the science learning process compared to memorize and in learning it meaningful, students must carry out cognitive processes that build relationships between information on concepts [12]. Mastery of concepts is very necessary to achieve student success in learning, with good mastery of concept, students are expected to be able to manage cognitive skills so that improvements can be made in further learning [13]. Students' mastery of concepts has a positive correlation with learning outcomes where if students' mastery of concepts is high, their cognitive learning outcomes will also be higher [4]. Based these definitions, it can be synthesized that concept mastery is a person's ability to understand the concept and meaning of learning and be able to apply it in her/his life.

3. PhET Interactive Simulation
Learning media is a set of tools used to help teachers convey information to students in the learning process. Along with the times and science and technology development, learning media are exist now not only media in their actual form, but there is already a medium called virtual laboratory. An example of such media is PhET (Physics Education Technology). PhET was created and developed by the University of Colorado, USA [6]. According to Mubarak quoted by Anggriani, PhET is an interactive simulation media in the form of software and can be used to clarify concepts or phenomena that have been practiced to replace the practicum activities at laboratory [4]. PhET can be downloaded for free for the benefit of learning both in the classroom (interest group) and outside the classroom for individual or personal interests and or group.

According to Fatik quoted in Hadiyanti, the advantage of the PhET simulation media is that it can ideally carry out experiments, which cannot be done using real tools. PhET simulation media is suitable for use as a physics learning medium to support the achievement of learning objectives [14].
Based on this explanation, it can be concluded that PhET is an interactive simulation in the form of a virtual laboratory that functions as a learning medium to clarify and prove the phenomena and concepts that have been studied. Learning to use that is done using a laptop or mobile phone as the medium, without having to practice directly using real tools or practicum kits. For this reason, that can be applied through distance learning activities.

As known that distance learning is a learning method that was originally developed in the United States, Germany, France, and England in 1800 using the media of letters. Then in 1980, International Correspondence Schools (ICS) built a system or lecture method at home, which became the forerunner of the distance learning system [15]. Distance learning is a learning method that is rapidly developing along with the development of technology, especially the internet. This method is not new to some schools, because previously they have implemented e-learning in their learning process. Based on various definitions by [16, 17, 18], it can be synthesized that distance learning is learning that is carried out at a distance without direct meetings between teachers and students at school by utilizing technology and the internet as a liaison.

4. Method

As a quantitative research, the research used the experiment method by providing treatment to research subjects to find the effect of such treatments on research subjects. The research design used was pre-experimental with a one group pretest-posttest design model. The following is a one group pretest posttest design research:

| Class          | Pretest | Treatment | Posttest |
|----------------|---------|-----------|----------|
| Eksperiment    | P1      | O         | P2       |

P1 : the pre-test scores before any treatment was given.
O : online learning process using the PhET Interactive Simulation.
P2 : the post-test scores after the treatment is given.

The sample of this research was selected using purposive sampling technique from all populations of class X of the science and mathematics group students of SMAN 1 Jakarta of the 2019/2020 academic year. The research data was collected by using an objective test in form multiple choices to measure the physics concept mastery ability, especially the harmonic motion. Prior to data collection, the research instrument was tested through various kinds of tests such as validity tests, reliability tests, and difficulty level and distinguishing tests of questions. The normality test as a prerequisite test is also carried out before testing the hypothesis using the paired sample t test and the N-gain test. Furthermore, an effect size test was also conducted to determine the strength of the effect of using the PhET interactive simulation in the online learning process to the high school students' mastery of the Harmonic Motion concepts.

5. Results and discussion

In this study, the treatment given to the experimental class was carried out in two lessons with a time allocation of 1x60 minutes per meeting. The allocation of time used adjusts to the online learning schedule for SMA Negeri 1 Jakarta. Online learning is carried out by utilizing the WhatsApp application as a medium for discussion and a liaison between teachers and students. The WhatsApp media were chosen because this application is the most popular application by the community as a means of communication and almost all students use it in their daily life. Virtual experimental assignments are given individually. Prior to the PhET assisted learning process, students are first given a pretest to measure the initial ability of students' mastery concepts.

After the PhET assisted learning process, students are given a posttest to determine the ability of students' mastery of concepts after learning with the PhET simulation. During the practicum activities of the harmonic vibration learning material by using PhET Simulation, discussions between teachers and students were also intensively carried out well. The students were asked and was identified be able
to answer properly and correctly the questions on the practicum sheet given. Furthermore, students should collect the results of the virtual experiment by sending them in the form of photos.

The research instrument was tested through various kinds of tests such as validity tests, reliability tests, and difficulty level and distinguishing tests of questions and declared to meet the requirements of the various forms of these tests for further used in collecting research data through pretest and posttest. Table 2 and figure 2 below shows the average scores of pretest and posttest.

| Data      | Number of Students | Minimum Score | Maximum Score | Average Score | Deviation Standard |
|-----------|--------------------|---------------|---------------|---------------|--------------------|
| Pretest   | 31                 | 20            | 50            | 47.42         | 13.89              |
| Posttest  | 31                 | 70            | 100           | 73.55         | 15.18              |

Based on the graph above, it can be seen that there is an improvement of students’ concept mastery as shown by the posttest results with an average of 73.55 after online learning using the PhET interactive simulation. This result was higher than pretest results of only 47.42 in average that indicated students’ concept mastery before online learning using PhET interactive simulation. However, prior to the hypothesis testing, the normality test was done to determine whether the data obtained is normally distributed or not. This normality test was conducted using the SPSS application with the Shapiro Wilk normality test since the number of samples is less than 50. The results of normality tests indicated that the collected data were normally distributed as shown with a significance value of higher than 0.05. The resulting data of normality test of students’ concept mastery abilities are stated in Table 3 below.
Table 3. The result of Normality test.

| Data   | Sig.  | Note  |
|--------|-------|-------|
| Pretest| 0.084 | Normal|
| Posttest| 0.058 | Normal|

Furthermore, the hypothesis test was carried out using the Paired Sample T-test by applying SPSS 23 to find out whether there is a to determine whether or not there is an effect of using PhET on mastery of the concept of harmonic vibration. The analysis result stated that the tcount (10.909) was higher than tab (2.042). It meant that Ho in this study was rejected and Ha was accepted. This can be interpreted that there is an effect of use that simulation of online learning physics on students' mastery of concepts, especially related Harmonic Vibration. The improvement of students’ concept mastery was also measured by applying the normalized gain test. N-gain of 0.51 was achieved to describe the improvement of students' concept mastery with medium category. This improvement can be described based on the major indicators of concept mastery as shown in figure 2.

![Figure 2. Achievement of Concept Mastery Indicators.](image)

Based on the research results as described above, it can be stated that the use of PhET Interactive Simulation in online learning physics can improve students' ability to master the concept of harmonic vibration. PhET Interactive Simulation helps students to be able to understand (memahami), apply (menerapkan), and analyze (menganalisis) concepts of physics, especially Harmonic Vibration. The results of this study are in line or relevant to the results of previous studies that have been conducted by several researchers. Concluded that learning with the experimental method in the classroom that was applying the PhET Interactive Simulation was more effective compared to use laboratory kit for learning the Gas Kinetic Theory material [19]. In addition, Susanto also concluded in his research that that can have a significant positive effect on students' problem-solving abilities in the subject of Hooke's Law [7]. Finally, also conducted a similar study and obtained the result that the use of that software as a learning medium has a positive effect on student physics learning achievement [6]. Generally, it is proven that the use of PhET Interactive Simulation in online learning physics has a positive effect on the high school students' concept mastery.

6. Conclusion
The Result of result can be concluded that the use of PhET Interactive Simulation in online learning physics, has a positive effect on increasing the ability to master Ionsep. That simulation can be used as a medium in online learning physics, especially for Harmonic Vibration.
Acknowledgments

Thank you to the Physics Teacher and Principal of SMAN 1 Jakarta for giving permission to research and helping during the research.

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