Improving concept understanding and motivation of learners through Phet simulation word

A Gani1,*, M Syukri1, K Khairunnisak1, M Nazar1, and R P Sari2

1Universitas Syiah Kuala, Darussalam-Banda Aceh, Indonesia
2Universitas Samudra, Langsa-Aceh, Indonesia

*Corresponding author: aganihaji@unsyiah.ac.id

Abstract. This study was aimed at determining the improvement of concept understanding and motivation of learners through physics education technology (PhET) simulation. Quantitative approach and quasi experimental technic were employed in this research. The populations in the study were four classes of 8th grade students of MTs Insan Qur’ani, while two samples were class VIIIc and class VIIId. The sample was determined by simple random sampling technic where VIIIc was treated as experimental group and taught using PhET while class VIIId was simulated as control group and was taught using a simple lecture method. 15 valid and reliable multiple choice questions were used as instrument to evaluate the concept understanding and motivation. While learners motivation was measured using 7 questions and was quantitatively analyzed. The test results of concept understanding undergo normality test, homogeneity test and hypothesis evaluation. The data show that the average result for the class of experiment was found to be 9.75% while for the control class was found to be 8.81%. Motivation questionnaire analysis results showed the significant increase in each item of statement, for the experimental class was found to be 85.6 while control class was 64.6, the score indicated that the students in the experimental class were more motivated in learning physics compared to the students of the control class. Based on the research findings, we conclude that PhET implementation in the classroom would enhance both concept understanding and motivations of students.

1. Introduction

Physics is one of knowledge areas related to the abstract concepts. It is called abstract because there is some matter of physics cannot be seen with the five senses. Therefore, the material of physics should be presented well so that the learners are able to understand the concepts taught by teachers.

Based on the result of observation that researcher conducted at MTs Insan Qur’ani was obtained that teaching learning process has been still conducted by teacher centered. The teacher explained the lesson in front of class while students usually inactive. In the process, teacher and students didn’t have chance to do the experiment where it surely can increase the understanding and motivation of learners for the material of physics learning. Based on interviewing by one of physics teacher there, the researcher got information that the school has no laboratory facilities because it has been still in development stage. This is a difficulty experienced by teachers in improving the motivation during the learners can be more active and increase their understanding. The result of mid-test in 2015/2016 showed that the average of learners in the physic learning is under minimal mastery criteria (KKM). It could be a challenge for the teachers to improve the learners’ low marks. These were caused by the lack of understanding of concepts and motivation in learning. So, teachers absolutely must think how to solve these problems. The understanding needs the ability of mastery the meaning of a concept which is being
discussed [1]. The understanding based on the level of responses and the mastery of concepts can be described in three levels; translation, interpreting, and extrapolation [2].

The low concepts understanding and motivation can be increased with the variety ways. Nevertheless, the researcher used one of using a suitable media in learning for learners influencing in learning positively. Explained that the using of media can improve the motivation of learning of learners during it can give the concentration of improvement of the concept understanding for learners [3].

One of the using of media which can solve the problem; there is no real laboratory is using a virtual laboratory. The virtual laboratory is a series of program that can visualize an abstract phenomena or complicated experiments which cannot be conducted by real laboratory. On the other hand, the real laboratory is a specific laboratory equipped by tools and real instruments to conduct an experiment [4]. Both of them possess the important role for learners. The stated that real and virtual laboratories have similar important role and the virtual laboratory can be mentioned as one of the alternatives to conduct the experiments for the learners because it can connect the nature phenomena that seem more realistic and can ease learners in doing an experiment in a lack facility schools so that may help in learning process and giving motivation for learners [5]. One of the virtual laboratories can be used to improve the concept understanding and motivation for learners is physic education technology (PhET). The PhET simulation is one of effective ways to instruct many physic concepts and function as alternative of traditional method such as laboratory activity and textbook [6].

The learning by using PhET would make learners more active, more interested learning uses PhET simulation due to learners can use PhET software animation and also can give a learning experience as well as playing [7,8]. PhET virtual media can train process skill to get the result of product cognitive and positive response of learners by using student’s worksheet (LKS) as supporting source [9,10,11]. Furthermore, the learning based virtual laboratory can increase the mastery of concepts [2]. The learning media by using computer simulation program to enhance the understanding of concept for learners fulfills validity and reliability criteria [12,13]. The using of PhET can evoke learners' motivation in learning [14,15]. The learners will be easier to understand the materials if their motivation could be firstly evoked.

The advantage of PhET simulation can be an approach of learning which requires engagement and interaction with learners, educate learners so that they have constructivism paradigm, where learners can combine the initial knowledge with the virtual findings of the executed simulation, make more interested learning because the learners can study even though playing for it, and visualize the concepts of science as a model. The research purposes to know the improvement of understanding of concepts and motivation learners through PhET simulation.

2. Methods
The method of this research used a quantitative approach with type of quasi experiment. The population in the study were all students of class VIII consisting of four classes. The sample in this research is two classes, namely class VIIIc and VIIId taken by random sampling. Class VIIIc is used as an experimental class by teaching PhET and class VIIId simulations as control classes using lecture methods. Instrument used in the form of 15 multiple choice questions that have been validated by experts and the problem has included valid and has the reliability. The data processing of result of concept understanding test consists of three, 1) normality test; to look the obtained data distributing normally or not. 2) Homogeneity test; can be useful to know whether the sample of research come from same population so that the result of education generally applies for population. 3) hypothesis testing; the obtained data was analyzed by using test-t statistic distribution and to know improvement learners’ pretest and posttest scores using the normalized gain Savinainen and Scott:

$$N\text{-gain} = \frac{S_{post} - S_{pre}}{100 \cdot S_{pre}}$$

then, the obtained scores were categorized as three criteria; high, medium, and low.
In this research, the researcher uses Likert scale to get motivation. Likert scale is used to measure attitude, opinion and perception ones or group about social phenomena happening. The motivation questionnaire in this study uses 7 statement items, it is used learners’ learning motivation testing conducted by quantitative analysis way that is percentage.

3. Results and Discussion
This research used the PhET simulation for experimental class and conventional method for control class, both of them equally were given topics: vibration and wave. The result of learners’ concept understanding improvement analysis was looked from obtaining pretest and posttest scores given. The purpose of this is to find comparing the result of learning and learners’ motivation before and after learning.

The result of concept understanding was analyzed by using pretest and posttest scores for experimental and control classes. Based on average value, both of them have the significant difference, by high score on experimental and control classes. The analysis of improvement of concept understanding of learners can be seen from obtaining pretest and posttest scores given. The result of concept understanding of learners, between experimental and control classes can be seen on the Figure 1.

![Figure 1. Value data of concept comprehension](image)

The using of PhET Simulation is combination more between real contact or real life phenomena and make use of computer so that it is more interested [16]. PhET can be enhanced with combining of concepts from the abstract to be real which can be combined with surrounding natural phenomena. The simulation of PhET can aid learners in calculating carefully on the concept studied by using the correct analysis [17]. The understanding of concept can improve through using media of learning applied by PhET simulation [18]. The utilization of PhET media can make learning more active and interactive so that influencing level of concept understanding of learners [19, 20].

According to result of t-test analysis for experimental and control classes, there is a significant difference for achievement of learners after applying PhET simulation. It is caused the virtual laboratory used can improve thinking skill, ease to analysis the concept, and create the creative learning for learners. The result furthermore, can be seen on the Table 1.

| Number | Classes  | t-value | Result  |
|--------|----------|---------|---------|
| 1.     | Experimental | 2.213   | 0.2483  | Any differences |
| 2.     | Control    |         |         |                   |
Based on the result of analysis of value $t_{cal} = 2.213 > t_{tab} = 0.2483$, stated that there is any differences among experimental and control classes for understanding of concept of learners after applying PhET simulation on the topic: vibration and wave.

According to the result of motivation questionnaire analysis given for learners after teaching learning process which data was proceed by microsoft excel can be obtained as the following Figure 2.

![Figure 2. Data of learners attention indicators](image)

Note:
1. Learners’ interesting and attention
2. Supporting and requirement in learning
3. Hope and ambition
4. Punishment
5. Gift
6. Praise
7. Safe environment

The increasing of learners’ interesting and attention indicators for lesson using PhET simulation on the experimental class 83.3% is very high, whereas on the control class applied as conventional 61.9% is adequate. It is caused by influencing of using PhET simulation is very interested so that learners focused their attention on the view. It is in line with the result found by explained that the utilization of PhET simulation can construct learners’ interest in learning [21]. On the motivation indicators for supporting and requirement in learning on the experimental class was obtained result as 92.7% is very high. In contrast with control class was obtained result as 61.9% is adequate. PhET simulation can support the learners in teaching learning activity because it is presented very simple during making them easy to understand concept. The result showed that they possess a strong desire to learn happily and a good atmosphere and ease to understand the concept so that having motivation to know the material learned. Moreover, added that the using of PhET simulation has obtained good responses for learners [17].

The improvement of hope and ambition indicators on the experimental class as 95.8% is very high. Whereas on the control class as 66.7% is sufficient. Both possess hope to achieve success in learning. Therefore, the learners have a strong desire to study material of physics. Stated that PhET simulation designed by contextual concept can make learners interesting to learn the concept of science [2,22]. Be different from its increasing of punishment on the experimental class as 75.0% is high, whereas on the control class as 63.1% is sufficient. Motivation of gift and praise indicators on the experimental class respectively as 95.8 and 78.1% is categorized very high. The indicators of them on the experimental and control classes as 65.5% is sufficient and 64.3% is sufficient as well. The result was caused they generally require praise from their teachers due to the praise is a pride for them. The last increasing of motivation indicator is conducive learning environment. On the experimental class as 78.1% is high, on the control class as 69.0% is adequate. The learners, of course, need comfortable learning environment, in terms of equipment relating to the lesson or good atmosphere in classroom. Added that PhET media is very helpful the learners in improving their self-potential until the learning
is not only understanding of concept but also it can help to improve interest and motivation of learning simulated to Bill concept [23].

Learning motivation of learners has improved so that it is said that learning by using PhET simulation succeed to create enjoyable and interested condition and can stimulate a strong desire to learn the concept of Physics. The motivation to learn, the learners may support to be active for teaching learning process including interaction between teachers and friends. If the motivation of learners is better, so the understanding of concept is better as well. The success of teaching is also influenced by teacher ability to design and create enjoyable condition in the classroom [10]. An active learning can be created by media. One of them is using PhET simulation in learning [14,24].

4. Conclusion

Based on the result of research and discussion can be concluded that the improvement of understanding of concept or motivation for learners happen after applying PhET simulation in learning about vibration and wave.

References
[1] Sudjana N 2013 Dasar-dasar Proses Belajar Mengajar (Bandung: Sinar Baru Algensindo) p 126
[2] Fuentealba C, Badillo E, Sanchez-Matamoros G and Carcamo A 2019 Eurasia J Math Sci Tech Edu 15 2
[3] Sanjaya W 2012 Strategi Pembelajaran Berorientasi Standar Proses Pendidikan (Jakarta: Kencana Prenada Media Group) p 87
[4] Swandi A, Hidayah S N and Irsan L J 2014 J Fis Indo 18 52
[5] Ajredini F, Izairi N, and Zajkov O 2013 Euro J Physics Edu 5 1
[6] Hartini S, Firdausi S, Mishbah and Sulaeman N F 2018 J Pend IPA Indo 7 2
[7] Lin K Y, Hsiao H S, Chang Y S, Chie, Y H and Wu Y T 2018 Eurasia J Math Sci Tech Edu 14 12
[8] Nurhayati F, Syarifah and Mutmainnah 2014 J Pend Fis Aplikasinya 4 2
[9] Gani A, Safitri R and Mahyana M 2017 J Pend IPA Indo 6 1
[10] Rani S A, Wiyatmo Y and Kustanto H 2017 J Pend IPA Indo 6 2
[11] Sari D P, Lutfi A, and Qosyim A 2013 J Pend Sains e-Pensa, 1 2
[12] Rosana D, Kadarisman N, Maryanto A and Sugiharsono A 2017 J Pend IPA Indo 6 1
[13] Palloan P, Amin B D and Herman 2014 J Sains Pend Fis 10 3
[14] Prihartiningtyas S, Prastowo T and Jatmiko B 2013 J Pend IPA Indo 2 1
[15] Sumargo E and Yuanita L 2014 Unesa J Chem Edu 3 1
[16] Kagan S 2010 American Assoc Physics Teach J 48 1
[17] Krisdiana A and Supardi Z A I 2015 J Inovasi Pend Fis 4 2
[18] Mubarrok M F and Mulyaningsih S 2014 J Inovasi Pend Fis 3 1
[19] Mutakinati L, Anwari I, and Yoshisuke K 2018 J Pend IPA Indo 7 1
[20] Lubis F M, Bukit N and Harahap M B 2015 J Tabularasa 12 1
[21] Herdiana M, Kurniawan E S and Ashari 2015 J Radiasi 8 1
[22] Stiawan E, Liliarsari and Rohman I 2014 J Pengajar MIPA 19 2
[23] Civelek T, Ucar E and Gokcol O 2012 Proc Social Behavioral Sci 47 1780
[24] Syaifulloh R B and Jatmiko B 2014 J Inovasi Pend Fis 3 2