Development of learning module based on physical simulation in improving understanding of physics concept of students

R Rosmiati[1, a], E Rahmawati[1], and L Suswati[1]

Physics Education Study Program, STKIP Bima, NTB

Rosebiru1@gmail.com

Abstract. This research is a development research that aims to develop a PHeT simulation-based learning module that is feasible to improve students' physics concept understanding. The learning module was developed using a 4D model with a trial model using one group pretest-posttest design. Trial learning module was conducted in the even semester of 2017 by taking the material of wave and sound in basic physics II course. Tests were conducted on 27 physics education students of STKIP Bima. Data collection used three techniques, namely: observation, test, and questionnaires; while the data analysis technique used quantitative descriptive analysis. The results showed that the learning module met the following criteria: 1) validity that based on (a) the conceptual validity of the learning module, the validity of 3.4 both categorized and the reliability of 85.71%; (b) the module readability level with the easy to understand category (99%).) the difficulty level of module is in the easy to understand category (about 0.0). 2) Practicality that based on: (a) student activity that reached 89% good category, (b) not all students had a laptop. 3) effectiveness that based on (a) improving students' physics concept understanding with a high criteria of N-gain score (0.88), (b) student response with average 3.00 were in the agreed category. Based on those results, it can be concluded that the development of learning module based on appropriate PHeT simulation learning can improve students' physics concept understanding and fulfil the criteria of validity, practicality, and effectiveness, so it is worth using.

1. Introduction

Physics is one branch of natural science that studies the nature, interactions, and symptoms of objects in nature. In its development, the basic concepts of physics in the form of pure and applied research not only support the physics development alone but also support the development of other science and technology that certainly can be applied in various fields in the world. As a science that studies natural phenomena, physics also provides a good lesson for humans to live in harmony under the laws of nature. The management of natural resources and environment and the reduction the natural disasters impact will not run optimally without a good understanding in physics (Permendiknas No. 24 of 2006).

As one of the compulsory knowledge taught in high school, physics as an applied science is taught through several methods of lecturing, discussing, and conducting experiments in the laboratory. These methods support each other in order to support the students' level of understanding in physics. [1] and [2] believe that conceptual understanding is a person's ability to understand something once something is known and remembered. According to [3], the increasing understanding of physics concepts is caused by students in learning build knowledge through learning activities. In addition, students also

learn to examine the problems in their real life so that learning becomes very meaningful. Physics concepts are self-explored by the students and use to solve the problems they are facing so that students experience physical and mental activity, also to understand physics concepts better.

One of the contents that can support education today is the utilization of information technology equipped with new educational features. Multimedia-based teaching system can present less interesting subject into non-monotonous matter and facilitates the delivery. Students can learn certain materials independently by using computers equipped with multimedia-based programs [4]. Kriek and Stols [5] state that utilizing multimedia-based teaching systems can also make it easier for students to understand physics concepts through virtual lab experiments. Physics, unsupported by experimental activities in the laboratory, can cause the students' level of understanding reduces because of 'fancy' theory alone. Information technology in education is applied in the form of multimedia as a soft module (software), which provides facilities for students to learn a material. The use of multimedia applications in learning will improve the efficiency, motivation, and facilitate active learning of experimental learning, consistent with student-centered learning, and guide learners to learn better [5].

From the survey data, most of the graduate students in Bima do not understand the physics concept that has been studied. This is proved by the physics final score of students gets 60 on average. Some of the factors that are indicated to be the cause are the students' background who come from the SMA/MA or equal with the non-science concentration and lack of experimental activities in the laboratory due to lack of tools and materials in the campus laboratory. Therefore, the need for an alternative can help students to understand the material concept. It can be said that the use of multimedia as alternative teaching materials in several campuses in Bima has not been widely used.

One of the virtual simulation media that can be used is physics education technology (PHeT) simulation [6] [7]. PHeT is a simulation created by the University of Colorado that contains simulations of physics, biology, and chemistry learning for the benefit of classroom or individual learning. The advantages of PHeT simulation are emphasizing the relationship between real-life phenomena and the underlying science, supporting an interactive and constructive approach, providing feedback and a creative workplace [8, 9]. Utilizing PHeT, students can perform activities as a scientist by doing exploration to generate a more understanding of the scientific concept. Students are able to explore simulations through their own interrogations, establish connections, and conclude the rules. In addition, it is expected that students are involved productively with the activities and behavior of scientists. This PHeT simulation has proven to be successful in both tasks during laboratory interviews and classroom activities. Based on the description above, an effort to develop simulation-assisted learning modules is needed [10, 11].

2. Methods

This research is a developmental research because it developed PHeT simulation-based learning module. The module development in this study used 4D model (Thiagarajan et al., 1974). The use of this model in a subject development is intended (1) to be able to define the learning requirements, (2) to design prototypes of learning modules, (3) to produce revised learning modules based on the input from the experts, (4) can use and disseminate learning modules that have been developed. The experimental design of the learning tools used pre-group pretest-posttest design of pre-experimental model. Before implementing the pretest O1, and after carrying out the learning using the module developed x is done the final test (posttest) O2.

Data collection techniques, among others:

1. Make observations to collect data relating to the behavior. In this research, the data were modularity, student activities, student responses and barriers to the modules application. Observations were made by two observers who followed the learning process that was trained first.
2. Give questionnaires. Questionnaires were given to students after they complete the learning activities. Questionnaires technique was in the form of a module assessment sheet which conducted by experts or educational practitioners by calculating the average assessment in which the two educational practitioners worked as its validators and questionnaire responses of students in the

measured by the number of students who agreed to minus the students who declared not agree multiplied 100 as well as the barriers to module development developed by the researchers seen from the comments of two observers who observed during the learning process. he researchers saw from the comments of two observers who observed during the learning process.

3. N-gain analysis shows different understanding of physics concepts before and after being given treatment. A normalized score gain indicates the effectiveness of treatment rather than score or posttest N-gain formulated by [12]. The purpose of using this instrument is to know the increase understanding of physics concepts after through module development. Analysis to know the improvement of conceptual understanding is done through descriptive statistics.

4. Students response, a form of the instrument in the form of a table with column consists of: description of question and assessment/opinion. This instrument was adapted from [13] and developed by researchers. The purpose of using this instrument was to know the student's response after using the module.

To analyze the responses of students by looking at the percentage of responses from all student participants KBM to module pengajan in this study using data analysis techniques:

1. Modules developed further review conducted by two assessors to provide an assessment in accordance with the instrument. The resulting data was analyzed descriptively qualitative. The average score (X) of the validator assessment results was interpreted in the rating category. Namely, the module validity level developed by matching the learning module assessment criteria. Assessment sheets developed were a validation of content, language, and question writing by two assessors in accordance with the instrument. The result data was analyzed descriptively qualitative. The average score (X) of the validator's judgment was interpreted by the rating category that was the module validity level developed by matching the validity assessment criteria

2. Analysis technique of module legibility level was done descriptively qualitative. The result data of scoring the module readability obtained the score, then a qualitative descriptive analysis was done to determine the module legibility which developed by matching and categorizing the module legibility criteria.

3. Analysis of module difficulty level was done descriptively qualitative. the results of the module difficulty assessment scores obtained a score, then conducted a qualitative descriptive analysis to determine the level of difficulty module developed by matching with the criteria of difficulty module categorization.

4. Student activity is all activity undertaken by the student during KBM lasted and assessed by two observers by using the instrument. The technique of data analysis used quantitative descriptive analysis. The data were analyzed by using the percentage of agreement formula.

5. Analysis of increasing understanding of student concepts of improvement in learning outcomes based on data pretest and posttest learning results were descriptive qualitative analysis. This analysis was intended to describe the improvement of understanding physics STKOM Bima physic education concept with the development of PHeT based learning module. This analysis, shown in table, was to compare the increased understanding of pretest and posttest concepts.

3. Results and Discussion

This research was piloted on 27 physics education students of STKIP Bima on wave and sound material of basic physics II course. The research results indicate that the PHeT simulation-based learning module developed met the requirements as explained below.

The validity of the learning module based on:

(a) Conceptual validity, obtained by the average validation module of two validators, ie 3.4 good category with reliability percentage 85.71% so that the modules are categorized valid and reliable. The PHeT simulation-based learning module created prior to review consists of 8 wave and sound material, material explanations and how to practice it on a PHeT simulation. The examples of related material issues (as shown in Figure 1) are added on the review results by two experts at the end of the students' experiment.

siswa mungkin salah mengira bahwa normal mode yang diberikan berhubungan dengan gerak massa yang diberikan.

Saran penggunaan simulasi

Siswa baik individu maupun berkelompok, memperkirakan amplitudo relative dari mode (*spectrum energy*) untuk gerak massa yang diberikan. Untuk satu dimensi, siswa dapat mematikan tampilan mode amplitudo dan fase menggunakan tombol "minus". Dalam keadaan proyektor yang mati, guru mengatur spectrum mode menggunakan *slider* kemudian mematikan tampilan *spectrum mode*. Ketika proyektor dinyalakan, maka siswa hanya kan melihat gerakan massa. Kemudian siswa dapat memperkirakan *spectrum energy* dan menuliskan jawabannya di lembaran kertas, sebelum nilai *spectrum* ditampilkan.

F. Soal

1. Jelaskan prinsip superposisi pada mode nomal?
2. Bagaimana menyesuaikan fase pada mode normal di sistem gerak?

Figure 1. Results of module improvements by two experts.

Assessment results by two assessors of the overall learning module obtained value of 33.8 which means being in either category. This value indicates that the learning module includes a valid device. Details of the assessment results can be seen in Figure 2.

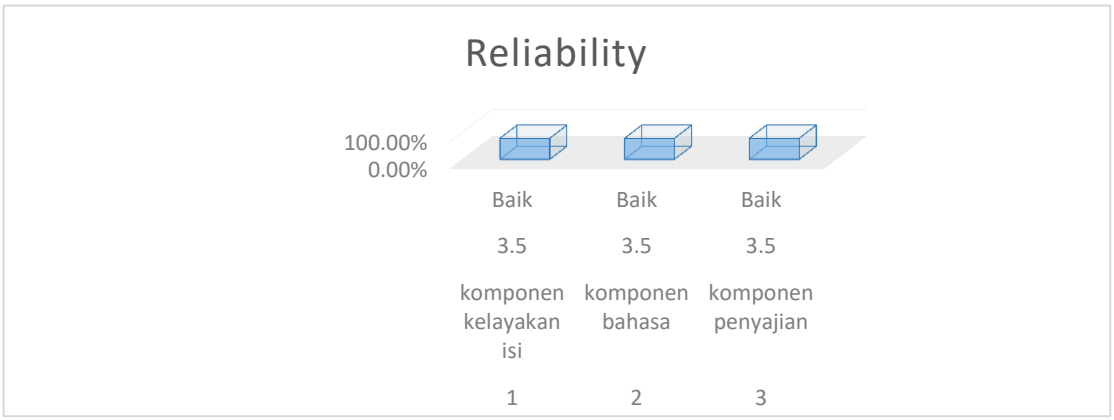

Figure 2. Results of module improvements by two experts.

(b) The degree of module legibility used the percentage of numbers based on the number of correct student answers. From the results of the assessment given to 27 students, the average level of module legibility is 99%. These results indicate that the degree of module legibility is in the easy to understand category.

(c) The modulated difficulty level of the average is 0.0. These results indicate that the module difficulty level is in the low category or very easy to understand.

The practicality of instructional devices based on:

(a) Observation of student activity conducted during KBM took place by two observers. The observation results indicate that the percentage of average class activity was dominated by reading module and installing PHeT, listening to teacher explanation, doing experiments, recording experimental results, analyzing data, and making conclusions. Only 14 out of 27 was giving opinions/communicating information to classmates and teachers with percentage 51.89% (Figure 3).

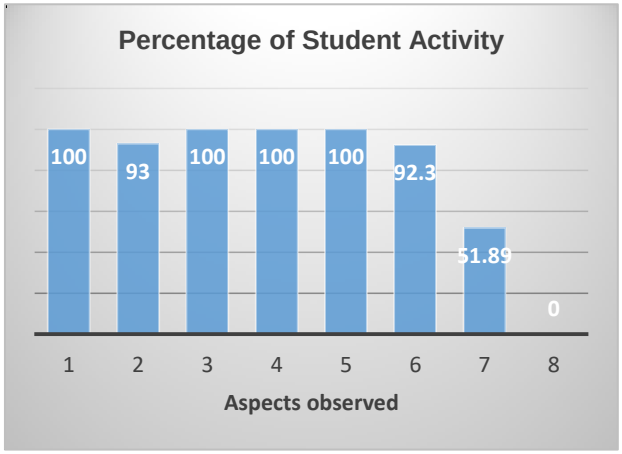

Figure 3 Percentage of student activity.

(b) The constraints recorded by the observer. the constraints are derived from the means of students that not all students have laptops

The effectiveness of learning devices based on:

(a) Improving the understanding of the concepts analyzed in this research is the improvement of understanding the concept of the product and the process. The development of PHeT simulation-based learning module that has been applied can be said to be successful because the improvement of concept understanding shows mastery over the KKM value of 75. Average improvement of the concept of product cognitive learning outcomes from field trial results can be seen in Figure 4.

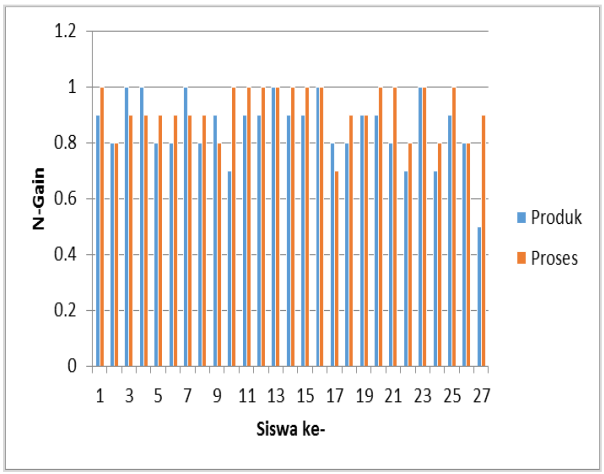

Figure 4 Graph of average increase in understanding of N-Gain physics concept students.

Increasing understanding of concepts using n-gain scores showed a high increase. Learning on a scale of values of 0.7-0.1 was in the high category [12] with an average of 0.88 being in the high category. This is because students understood the concept of wave and sound taught by lecturers. Researchers considered that students were more concentrated and enthusiastic in learning because the use of PHeT simulation-based learning module on physics assisted them in understanding abstract concepts greatly [14].

(c) Students response in research is how student's response after applying PHeT simulation-based learning module. There are 15 statements with an average of 3 on the agreed category for the student response, described in Figure 5.

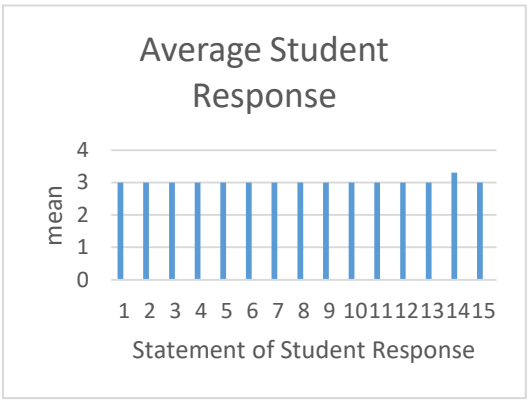

Figure 5 Graph of Student Response Average.

4. Conclusion

Based on the result of research and discussion, it can be concluded that the development of PHeT simulation-based learning module in improving physics concept of students concept, fulfilling the criteria of validity, practicality and effectiveness, so it is worthy to be used.

Acknowlegments

With the completion of this scientific work, the authors express their deepest gratitude to the omnipotent God for the abundance of His gifts and guidance so that the writer can carry out research and complete the scientific work, also for Kemenristek dikti that has been funded entirely as a study of novice lecturers (PDP) and students of physics education program at STKIP Bima for their cooperation during the research.

References

[1] Wiyono K, Setiawan A, and Paulus C T 2012 Model Multimedia Interaktif Berbasis Gaya Belajar *J. Pendidik. Fis. Indon.* **8 (1)** 74
[2] Bigozzi L, Tarchi C, Falsini P, and Fiorentini C 2014 Slow Science: Building Scientific Concepts in Physics in High School *Int. Sci. Educ.* **36 (13)** 2221
[3] Hermanto W, Kusairi S, and Wartono 2013 Pengaruh Blended Learning terhadap Penguasaan Konsep dan Penalaran Fisika Peserta Didik Kelas X *J. Pendidik. Fis. Indon.* **9 (1)** 67
[4] Podolefsky N S, Perkins K K, and Adams W K 2010 Factors Promoting Engaged Exploraton with Computer Simulations *Phys. Rev. ST Phys. Educ. Res.* **6 (2)** 1
[5] Kriek J and Stols G 2010 Teachers' Beliefs and their Intention to Use Interactive Simulations in their Classrooms *South Africa J. Educ.* **30** 439
[6] Grandgenett N 2011 PhET Interactive Simulations *Math. Comput. Educ.* **45 (1)** 83
[7] Clark T M and Chamberlain J M 2014 Use of PhET Interactive Simulation in General Chemistry Laboratory: Models of the Hydrogen Atom *J. Chem. Educ.* **91 (8)** 1198
[8] Mursalin 2013 Model Remediasi Miskonsepsi Materi Rangkaian *J. Pendidik. Fis. Indon.* **9 (1)** 1
[9] Budiono E and Susanto H 2006 Penyusunan dan Penggunaan Modul Pembelajaran Berdasar Kurikulum Berbasis Kompetensi Sub Pokok Bahasan Analisa Kuantitatif untuk Soal-soal Dinamika Sederhana pada Kelas X Semester 1 SMA *J. Pendidik. Fis. Indon.* **4 (2)** 79
[10] Wieman C E, Adams W K, Loeblein P, and Perkins K K 2010 Teaching Physics Using PhET Simulations Phys. Teach. 48 (4) 225
[11] Adams W K 2010 Student Engagement and Learning with PhET Interactive Simulatins *Il Nuevo Cimento* **33 (3)** 1
[12] Hake R R 1999 *Analyzing Change/Gain Scores* Available at: htttp://www.physics.indiana.edu/~sdi/AnalyzingChange-Gain.pdf unpublished work)

[13] Kristanto A 2011 Pengembangan Model Media Video Pembelajaran Mata Kuliah Pengembangan Media Video/TV Program Srtudi Teknologi Pendidikan Fakultas Ilmu Pendidikan Universitas Negeri Surabaya *J. Teknol. Pendidik.* **11 (1)** 12