

Improving Students' Concept with POE2WE Learning Model Assisted by PhET Android Simulation

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Abstract: The purpose of this study is to determine the influence of the POE2WE learning model assisted by the Android Lab Virtual PhET application on students' understanding of the Equilibrium of Rigid Objects. The type used in this study was quasi-experiment with research subjects of SMA Negeri 2 Medan students class XI MIPA 7 as an experimental class and XI MIPA 8 as a control class. The data analysis technique used is quantitative. The results of the research obtained were the influence of the POE2WE learning model assisted by the Android Lab Virtual PhET application on students' understanding of concepts on the equilibrium material of rigid objects in the medium category with an n-Gain test of 58.6%. Based on the results of the study, the application of the POE2WE learning model assisted by the PhET virtual android lab application can increase students' understanding of concepts on the equilibrium rigid body material.

Keywords: Concept understanding; PhET android simulation; POE2WE learning model.

Introduction

Education is an aspect that keeps up with the times. Education is also the basis for people to be ready to live and develop in various fields in improving the quality of life. Improving the quality of education is carried out so that the quality of human resources also improves through improving the quality of education in schools. The world of education has goals that must be achieved in the learning process (Merliana, 2019).

Improving the quality of education is carried out so that the quality of human resources also improves which can be done in schools. Education is not something static but something dynamic that demands continuous improvement. The world of education has goals that must be achieved in the learning process (Nana, 2020).

However, in achieving the planned learning goals, there are various obstacles. Education in the world at the beginning of 2020 experienced a major change, which happened due to the health crisis that was sweeping the

world, namely the Covid-19 pandemic. United Nations Educational, Scientific and Cultural Organization (UNESCO) on March 4, 2020 suggested opening an education platform for the implementation of distance education that can be used by teachers and schools to limit educational disruptions and reach learners remotely (Setiawan, & Aden, 2020).

The Ministry of Education and Culture of the Republic of Indonesia followed up by issuing Circular Letter Number 4 of 2020 concerning the Implementation of Education Policies in the Emergency Period of COVID Spread on March 24, 2020. The circular explained that the entire learning process that originally took place face-to-face in schools will be transferred to learning carried out from home through online learning or online learning (Dewi, 2020).

In 2022 the Ministry of Education and Culture Republic Indonesia again issued Circular No. 2 of 2022 regarding the implementation of learning, namely Limited Face-to-Face Learning (LFFL) at 50%. The

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application of LFFL raises various problems. One of them resulted in the ineffectiveness of the implementation of learning during the Covid-19 pandemic. LFFL is limited learning by regulating amounts of students that the number of students is less than the normal as they have to adjust the distance of chairs and tables in the classroom according to health protocol. The ineffectiveness of learning in the form of material provided in LFFL is only in the form of core or most essential material. The submission of material that is not optimal is related to the limited duration of learning. This makes the burden on teachers heavier, as teachers have to carry out teaching twice on LFFL schedule in groups of students who are divided in half every class (Mubarok, 2022).

Efficiency is how to produce the effectiveness of a goal with an easier process. As happened in 2020, education in the world has undergone a major change due to the health crisis that has hit the world, namely the Covid-19 pandemic. The Covid-19 pandemic has made many countries in the world decide to close schools and universities, including Indonesia. The United Nations (UN) even revealed that one of the sectors that has been so affected by this pandemic is education (Purwanto, Pramono, Asbari, Santoso, Wijayanti, Choi, & Putri, 2020).

The same obstacle was also found in SMA Negeri 2 Medan. Based on the results of observation at SMA Negeri 2 Medan and interviews with physics teachers, it was found that learning information was carried out in a blended method, namely 50% face-to-face and 50% online. Physics learning is carried out once in 2 weeks. The method used is lectures and assignments both individually and in groups. This method was carried out because of the limited learning time which resulted in learning to be teacher centered which should be student centered according to the curriculum used. Physics practicum cannot be carried out as usual. The implementation of LFFL is less effective, resulting in a lack of understanding of students' concepts of the material being studied.

Concept understanding is one of the ability factors that affect student learning outcomes. Concept understanding is the ability to define or state concepts using one's own mind (Sumarmo, Hendriana, & Rohaeti, 2017). Concept understanding is also the ability to apply concepts (Bonaci, Mustata, & Ienciu, 2013).

Things that can be done to overcome the lack of effectiveness is applied appropriate learning model. The learning model is a form of learning from beginning to end which is presented specifically by the teacher. The learning model is a series of approaches, methods, strategies, and learning techniques (Helmiati, 2012). The learning model that accordance to LFFL implementation is the application of the Prediction, Observation,

Explanation, Elaboration, Write, and Explanation (POE2WE) learning model. The Prediction, Observation, Explanation, Elaboration, Write and Evaluation (POE2WE) learning model was developed from the POEW learning model and the Physics learning model with a Constructivistic Approach. According to Nana (2018) the POE2WE model is a learning model developed to find out students' understanding of a concept with a constructivistic approach. This model builds knowledge by the sequence of processes of first predicting or predicting the solution of problems, conducting experiments to prove predictions, then explaining the experimental results obtained orally or in writing, making examples of application in everyday life, writing down the results of discussions and making evaluations about students' understanding of concepts both orally and in writing (Nana, 2019).

The application of technology to improve students' understanding of concepts is also one of the relevant efforts made today. One of the technologies that can be utilized in physics learning is a virtual laboratory. The laboratory that was originally developed on PC developed until now it is already available in smartphone applications. Android-based applications are developed to conduct practicum virtually. The use of smartphones for physics learning activities provides students with comfort in learning (Gonzalez, Gonzalez, Martin, Llamas, Martinez, Vegas, & Hernández, 2015). Virtual Laboratories are used as simulations for experimental material that is abstract, difficult to understand, and lacks laboratory facilities and infrastructure (Darmayanti, Islam, & Asandhimitra, 2004).

Researchers reported a study on how androids can be used to improve teaching and learning in high school science. The results show that using pictures and videos on mobile phones can support teachers not only in bringing the outside world into the classroom but also in providing instruction, in assessing student learning and improving student understanding. (Ekanayake & Wishart, 2014). Mobile technology has the potential to support various activities such as exploration, communication, and documentation in experiments. Students, prefer to study in a simulation and exploratory environment where they can solve problems, work as a team or individually (Li, Zhou, & Teo, 2018). One study stated that mobile devices can successfully replace computers and positively affect students' academic activities (Sakibayev, Sakibayev, & Sakibayeva, 2019). The advantage of using mobile devices in addition to academic performance is that it is economical because it does not require special equipment in the classroom and psychologically creates a sense of comfort for students who are accustomed to using mobile devices (Shyshkanova, Zaytseva, & Frydman, 2017).

One of android virtual application is PhET android simulation. The PhET application was developed using interactive multimedia-based computer technology and can be used as a virtual laboratory. Interactive multimedia is included in it, namely in the form of video formats, animations, graphics, images, audio, text, and hypertext (Gunawan, Setiawan, & Widyantoro, 2013). This application can be accessed through the website and downloaded for free via the android play store. This application is easy to reach because most teachers and students are already using android-based phones (Adam, Rizal, & Susilawati, 2021).

As a result of observations and interviews with physics teachers at SMA Negeri 2 Medan, learning was carried out in a mixed manner, namely 50% face-to-face and 50% online. The method used is lectures and assignments both personally and in groups. The physics practicum has also not been implemented as usual. This results in a lack of understanding of students' concepts towards the learning material. Students have difficulty understanding concepts due to the limited time to learn with methods that should require more time. Based on problems in the learning process, researchers provided solutions to apply the POE2WE model based on android virtual labs. Research is expected to improve students' understanding of concepts and make student-centered.

Concept understanding can also be improved through the application of technology, one of which is a virtual laboratory, which is an application to provide theoretical material equipped with images, animations, and videos. It aims to enable students to study independently. The virtual laboratory is designed to be an interactive laboratory simulation so that students can be directly involved in observing, measuring, and collecting virtual laboratory data (Billah & Arif, 2018).

Android-based practicum is also a solution to the limitations of learning time in schools and the limitations of practicum facilities and infrastructure. The application in smartphone was developed to do a virtual practicum. The use of smartphones for physics learning activities provides students with comfort in learning (Erfan, Maulida, Hidayati, Widodo, & Ratu, 2021). Convenience includes flexibility in accessing higher-level learning. Students can build understanding through continuous and independent simulation and evaluation activities (Arista & Kuswanto, 2018).

The use of android virtual lab is more efficient because all students of SMA Negeri 2 Medan already use smartphones so that it does not burden students or teachers. This problem makes researchers conduct research "Improving Students' Concept with POE2WE Learning Model Assisted by PhET Android Simulation." This is in line with the research results of Ramadhan (2020) which states that the application of the POE2WE model results in increased understanding of the concepts

and the results of Sidik, & Nurmahmuddin, (2020) research that stated that the POE2WE model is effectively applied in the classroom.

Method

This research was conducted at SMA Negeri 2 Medan, Jl Karangsari No 435, Sari Rejo, Medan Polonia Subdistrict, Medan City, North Sumatera in class XI MIPA Semester II of the 2022/2023 Academic Year in August to October 2022. This type of research is known as quasi-experimental. This study involved two classes, namely the experimental class and the control class which were given different treatment. Experimental classes are taught with the Virtual Android Lab's rocky PO2WE learning model while control classes are taught using conventional learning models.

The research was conducted in three stages: preparation, implementation, and final stage. The preparation stage involved discussions with the supervisor, interviews with teachers at SMA Negeri 2 Medan, and observations of the learning process, models, and outcomes. The results of observations and interviews were then analyzed, followed by a review of relevant literature to address the identified problems. In addition, learning materials, lesson plans, and research instruments were prepared for use in the study.

The implementation stage began with expert validation of the research instruments, followed by selecting sample classes consisting of one experimental class and one control class. A pretest was administered to both classes before the learning process. The experimental class was then taught using the POE2WE model assisted by a virtual Android lab, while the control class received conventional instruction. Afterward, a posttest was conducted in both classes. The data obtained were analyzed through normality, homogeneity, and hypothesis testing, which served as the basis for drawing conclusions.

Conceptual understanding was assessed through pre-test and post-test consisting of seven descriptive questions, administered using both the POE2WE and conventional learning models. The test instruments were validated by experts to ensure accuracy, as validity reflects the extent to which an instrument appropriately measures and reveals data related to the research variables (Arikunto, 2016). The value of concept understanding test is calculated and analyzed to get N-Gain test in the final.

Result and Discussion

In the initial stage of research, both classes were given a pretest and posttest to see students' concept concepts in the equilibrium material of students' rigid

objects in both classes. The data on students' learning concept scores in this study were seen from the average score of learning concept before and after learning was

carried out using a conventional learning model and POE2WE learning model assisted by android PhET simulation. The data can be seen in Table 1.

Table 1. The Difference in the Average Score and Data Analysis of Students' Concept in Experiment and Control Class

Data Group		Mean	SD	Normality Test	Homogeneity Test	Hypothesis Test	N Gain
Eksperiment	Pretest	26.47	7.55	0.09	1.37	0.46	58.60%
	Posttest	69.00	13.42	0.08	1.99	9.74	31.30%
Control	Pretest	25.82	8.83	0.15	1.37	9.74	31.30%
	Posttest	49.53	9.52	0.14	1.99		

The average value of students' understanding of physics concepts using the POE2WE learning model assisted by the PhET virtual lab android application and the cooperative learning model in the control class. The results show that students' understanding of physics concepts in the experimental class improved from an average pretest score of 26.47 to a posttest score of 69.00, with a gain of 42.53. In the control class, the average pretest score of 25.82 increased to 49.53 in the posttest, yielding a gain of 23.71. Both the pretest and posttest were administered using the same set of seven essay questions. Based on the posttest results analyzed through a t-test, it was found that there was a significant difference in students' conceptual understanding when taught using the POE2WE learning model assisted by the PhET virtual Android lab compared to the cooperative learning model.

The effect of the POE2WE model assisted by the PhET virtual lab Android application is reflected in the n-gain results, with 58.60% in the experimental class and 31.30% in the control class, both categorized as medium. The n-gain comparison between the two classes is presented in Figure 1.

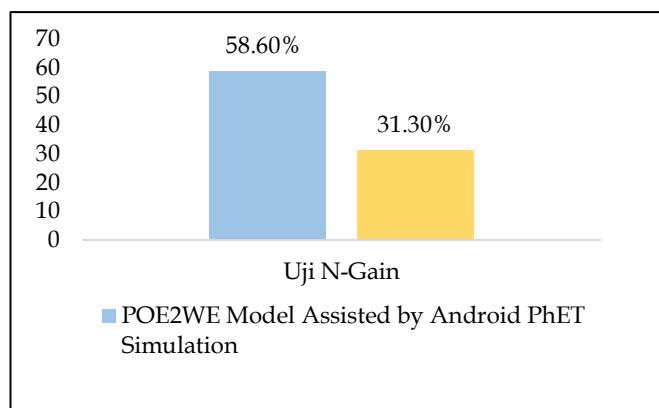


Figure 1. N-Gain Test Experiment and Control Class

The student's understanding of physics concepts can be analyzed through normalized gain (n-Gain). n-Gain data is obtained through pretest and posttest of both classes. Normalized gain tests were conducted to measure the improvement in students' understanding of

physics concepts by applying the POE2WE learning model assisted by the PhET virtual Android lab in the experimental class and the cooperative learning model in the control class. The n-gain results for both classes fell into the medium category, with 58.60% in the experimental class and 31.30% in the control class. These findings indicate that the improvement in conceptual understanding in the experimental class using the POE2WE model with PhET virtual lab support was greater than that in the control class using the cooperative model.

In the implementation of the POE2WE learning model, researchers carried out six stages: (1) Prediction, the teacher presents a problem about the reliability of tough objects and students respond with their own predictions through direct questioning, (2) Observation, students conduct experiments using the PhET virtual Android lab application to verify their predictions, (3) Explanation, students are divided into groups to present and explain their experimental results, while the teacher provides clarification and reinforcement, (4) Elaboration, students explore the application of concepts based on the experiments conducted, (5) Write, students record the concepts, knowledge, and conclusions obtained from the experiments and presentations, and (6) Evaluation, the teacher gives post-test questions to assess students' conceptual understanding based on the knowledge gained.

The POE2WE model assisted by the PhET virtual android lab application applied to the experimental class had a greater effect than the cooperative model applied to the control class with a difference of 27.3%. There are differences in the concepts of students in experimental classes and control classes because the POE2WE model learning model assisted by the PhET virtual lab android lab application requires students to play an active role in learning and realize learning concepts in the form of virtual experiments. In addition to the POE2WE learning model, students' understanding of concepts is also supported by the use of the PhET virtual android lab application at the experimental stage. Nana (2020) in her research stated that through experimentation the learning process becomes more interesting, interactive,

the number of teachings can be reduced, the quality of learning is improved and the teaching and learning process can be done anywhere and anytime. According to Tarmizi, Halim, & Khaldun, (2017) the experimental method involves students to plan experiments, find facts, collect data and solve problems encountered in real time or prove for themselves something learned. The experimental method provides an opportunity to students to observe, analyze, prove and draw conclusions of the process or state of an object. The experimental method trains students to find the truth of the theory making it easier for students to understand the concept being studied. There are differences in the concepts of students in the experimental class and control class because the POE2WE learning model assisted by the PhET virtual lab android application requires students to play an active role in learning and realize learning concepts in the form of virtual experiments. Besides that, students are also required to relate concepts that are understood through experimentation with concepts that exist in everyday life so that the concept is more meaningful and easy to understand. In addition to the POE2WE learning model, students' conceptual understanding is also supported by the use of the PhET virtual lab android application at the experimental stage. Nana (2020) in his research states that through experimentation the learning process becomes more interesting, interactive, the number of teaching can be reduced, the quality of learning is improved and the teaching and learning process can be done anywhere and anytime.

Although there is an increase in students' better understanding of concepts by using the POE2WE model assisted by the PhET virtual lab android application, there are also some obstacles faced by researchers in the research process. The obstacle is the use of the PhET virtual lab android application which is still very new so that students are still adjusting and resulting in additional time at the experimental stage and the lack of preparation of researchers in delivering the application so that there are students who cannot download the application due to memory or internet package constraints. Researchers overcome this obstacle by dividing students into groups so that students who do not have an application join their group of friends and use their group of friends' applications. These obstacles can still be handled even if they are not optimal. This can be proven from the increasing understanding of students' concepts using the POE2WE model assisted by the PhET virtual lab android application. This improvement is also better than improving students' understanding of concepts using a cooperative model. So that the application of the POE2WE model assisted by the PhET virtual android lab application can increase students' understanding of concepts.

Conclusion

There is an improvement of the POE2WE learning model assisted by the PhET virtual lab application on students' understanding of the concept of rigid body equilibrium. The improvement can be seen from the increase in the average understanding of students' concepts before being treated, which is 26.47 and after being treated with the POE2WE model assisted by the PhET virtual lab android application of 69.0 with the n-Gain test of 58.6% with a difference in pretest and posttest values of 42.53.

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Author Contributions

Conceptualization, formal analysis, funding acquisitions, data curation, methodology, investigation were prepared by Deo Demonta Panggabean. Project administration, resources, software, validation were settled by Grace Dita Maria Naibaho. Visualization, writing original draft and writing review & editing were done by Ika Trisni Simangunsong.

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Conflicts of Interest

This research did not receive external funding that authors stated that this research was not influenced by personal interests or certain groups.

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