

THE IMPACT OF PHET-ASSISTED EXPERIMENTAL LEARNING METHODS ON STUDENTS' SCIENCE PROCESS SKILLS IN SCIENCE TOPICS

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ABSTRACT

The focus of this study is to find out how the PhET-assisted experiential learning technique affects students' Science Process Skills on energy-related material. A quantitative technique was applied in the research design, which was one group pretest posttest. This study will take place in SMPN 1 Sugio Lamongan. Purposive sampling was used in the sample selection process. There were 181 students in this study. The research included 66 students divided into two groups, class A and class B. However, data could not be gathered for 5 kids due to school activities, limiting the sample to 61 students. The insight gathering approach involves cognitive tests and observation of performance tests, followed by hypothesis evaluation with a paired simple t-test. The findings of this investigation show that learning using the PhET-assisted experimental approach to learning encounters a substantial impact on students' Science Process Skills in energy change material, with an average cognitive pretest score of 40.03, a posttest result of 78.95, and an N-gain value of 0.64, and obtained data from performance test observations with a pretest value of 35.65, a posttest result of 84.42, and an N-gain value of 0.75. The integration of experiential learning techniques aided by PhET has an impact on students' Science Process Skills, as evidenced by pretest posttest outcomes that have increased to the moderate level.

Keywords: experimental learning method; *PhET*; *science process skills*

INTRODUCTION

The enactment of an instructional program in classrooms so that students can reach predefined goals is referred to as the learning stage. In general, the learning objectives urge all pupils to develop their intellectual, moral, or socio-cultural good acts. Its application also necessitates that students be more innovative in their learning processes, particularly in science courses (Ali, 2019). In particular, science includes three components: the scientific stage, scientific products, and scientific acts, and it is divided into the three fundamental science sectors: physics, biology, and chemistry (Trianto, 2010). Science is associated with methodical exploration of nature, therefore science is

not simply a grasp of knowledge that comprises evidence, concepts, and principles, but also a search and trial stage. (The Ministry of Education and Culture, 2014).

Indonesia's worldwide successes in scientific process skills remain quite poor, as evidenced by the country's inclusion in TIMSS. TIMSS (patterns in Mathematics and Science Study) is a specific study that looks at patterns in math and science learning. The TIMSS questions are directly connected to scientific process skills. The Ministry of Education and Culture (2016) According to the TIMSS Infographic, the average correct answer for students in science disciplines in Indonesia is 32, whereas the global standard is 50. In 2015,

Indonesia placed 45th out of 48 nations in science disciplines, with a score of 297 points.

Data was acquired from interviews conducted with science instructors at Sugio State Junior High School 1 on October 20, 2022, indicating that the learning phase was still dominated by the lecture technique, with teachers dominating in showing the information being taught. As a result, students' enthusiasm in learning decreases, and pupils become less passionate about carrying out learning. Due to an abundance of infrastructure at the research site, only around 30% of educators use experiential learning approaches in the classroom. The results of the researcher's observations during class instruction demonstrated that while employing the teacher's approach, only 15% of the students in the class remained attention, resulting in an inactive learning environment and a poor degree of student understanding. This is demonstrated by the pupils' test scores, which revealed that 60% matched the criterion. Minimum completeness (KKM) of 70 for the school. Teachers must grasp students' characteristics and investigate acceptable techniques for directing students so that students may be happy, comfortable, and can link directly to something genuine and found in everyday life - their day throughout the learning process.

The highlighted challenge is that there is a need for a learning approach in which students may participate directly in the learning phases and experience discoveries related to the topic being studied. A scientific technique is the experimental teaching approach (Yusak Ratunguri, 2016). The experiment-based learning technique is a type of learning that

requires pupils to do systematic experiments with phases of scientific activity. The experiential learning approach has the benefit of improving behavior in carrying out exploratory research in science and technology, thus it does not induce lethargy in students. Initial experiment, investigation, initial hypothesis, verification/carrying out trials, and assessment are the phases of executing the experimental method (Palendeng Hamdayama, 2014). The use of an online laboratory can help with the implementation of experimental learning approaches (Latjompoh et al., 2021). Virtual labs are an effective learning tool based on computer simulations that originated from laboratory studies (Henry et al., 2021).

PhET is a form of virtual laboratory. PhET (Physics Education Technology) is an example of instructional media explored at the University of Colorado using virtual labs, including theoretical simulations and experiments involving active users (Sulikin, 2017). PhET is being explored in order to assist learners in mastering the visual stage. An instructor can create students' conceptual insights by explaining things that cannot be seen with the naked eye using PhET (Maulina R N dan Kustijono R, 2017). PhET may assist students' learning processes through a variety of ways and approaches, allowing students' knowledge to be improved while simultaneously developing skills during the learning process. Students require many different types of abilities, one of which is science process skills. Science process skills are the abilities or competence of students who perform scientific techniques in order to master, enhance, and get information (Rahayu, 2022). Coming up

with hypotheses, forecasting, discovering patterns, and determining variable correlations are examples of these talents or abilities (Hannasari et al., 2017). Science process skills (KPS) may be used to apply a scientific approach to science education (Nuzulia, Adlim, 2017). Science process skills are an important indication of conveying the insights required to manage disagreements and obtain information in experiments (Alatas & Sakina, 2019).

METHOD

The investigation at hand takes a quantitative approach with a Pre-Experimental research design. A quantitative technique is used by researchers because this research involves a population and sample by collecting data using specified instruments and evaluating the data with the goal of testing a theory, demonstrating a certain variable, and formulating a hypothesis. The "one group pre-test and post-test design" was utilized in this investigation. This investigation was conducted at Sugio 1 State Junior High School in Dusun. Sugio is a village in Japan. Sugio is located in the Sugio District of the Lamongan Regency.

This study was conducted during the even semester of the 2022/2023 school year, or roughly January-July 2023. Purposive sampling was employed to choose samples. Purposive sampling is a technique for picking samples based on certain criteria (Sugiyono, 2015). This decision was taken when it was determined that pupils in particular classrooms did not learn Science Process Skills adequately. Suharsimi Arikunto, who argues that if there are less than 100 people, it is best to take all of them so that the research is population research, guides researchers in

gathering samples. Furthermore, if the subject is vast (more than 100 persons), a sample can be used. According to him, samples are obtained from 10% - 15% of the current population to 20% - 25%, or even more than 25% (Arikunto, 2012). According to the clarification, which is the overall population was 181 students from classes A-F, and the research picked a sample of 66 students from Sugio 1 State Junior High School, Lamongan, East Java, consisting of two classes, namely 32 students from class VII A and 32 students from class VII B 34 total.

Cognitive examinations and outcomes of test observations in the form of pretests and posttests are used to collect data in this study. The data was initially examined for preliminaries, which included the Kolmogorov-Smirnov test technique and homogeneity testing using the Lavene-test technique to determine homogeneity and normality with a significance value of 0.05. The data obtained from the research results were then analyzed using the N-Gain test analysis technique to determine the improvement in the PhET-assisted experimental learning method, as well as the t-test to determine the effect of using the PhET-assisted experimental learning method on students' Science Process Skills.

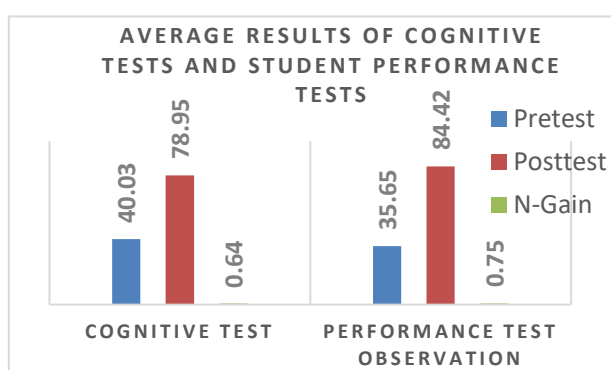
RESULTS AND DISCUSSION

This study collected numerous sorts of data, including student pre-test score data, student post-test score data, N-Gain test data, and paired sample t-test findings, all of which were analyzed using SPSS version 26 software. Paired sample t-test, employing 0.000 or 0.000 <0.05. This suggests that H_a was approved and H_o was denied, or that a

substantial relationship was discovered between the performance test and the PhET-assisted experiential learning approach on students' Science Process Skills in science courses involving energy changes.

Figure 1. Average results of cognitive tests and performance tests.

Figure 1 shows the average pretest and post-test score for the class of cognitive test results, which was 40.03 before treatment and 78.95 after treatment, with an



N-gain value of 0.64, indicating a growth in the medium range. Figure 1 shows that the pretest and post-test scores for the class of students' performance test results before treatment were 38.65 and 84.42, respectively, with an N-gain value of 0.75, indicating a growth in the high category.

The findings of the previously disclosed overall hypothesis testing reveal that the PhET-assisted experiential learning technique has an effect on students' Science Process Skills. Because the learning process is oriented on students, experimental learning approaches have the potential to affect students' Science Process Skills. The improvement in students' cognitive ability may be demonstrated in the moderate group, where the N-Gain score is 0.64, indicating that students grasp the

energy that has to be modified in its utilization.

Students' skills may be improved since they explicitly try scientific investigations despite using a virtual laboratory, as evidenced by the outcomes of performance test observations with high criteria, specifically a score of 0.75. Virtual laboratories provide various benefits, including the ability for students to adjust the variables utilized during practicum without having to consider potential negative consequences when experiments are carried out in the actual world (Agustina et al., 2020). Students may use the conversion of energy material to substitute different existing energy sources, such as temperatures, movement, and food energy, which will then be turned into various other energies such as electrical energy and motion energy. Interestingly, in this PhET-assisted experiment, students may simply modify the intensity of the energy source used, allowing them to directly examine the influence of diminishing energy sources on other energy sources (Putri et al., 2018).

Learning in school is undoubtedly planned in advance by the teacher, but this preparation is also linked to events that occur in the actual world, particularly when solving complicated issues that demand thorough and systematic thinking processes (Thuneberg et al., 2018). Experimental educational activities put students at the center of the teaching and learning process, allowing them to be more actively involved in the learning process; also, experimental learning can assist improve crucial abilities, creativity, and

ability to solve issues (Roth et al., 2021). Throughout the investigation process, students practice practicums using their personal smartphones, and there is a method of working on The LKPD course in groups, where each individual may address current difficulties and then students can correct each other during the presentation. The goal of combining individual and group learning strategies is to ensure that students not only develop the science process skills they are trained in, but also social skills, arguing, collaborating, and accepting other people's opinions during discussions.

This mix of virtual and offline learning gives students the impression that technology is extremely near to their life and can enrich their educational experience (Maulina R N dan Kustijono R, 2017). Learning using virtual laboratory aid can help students enhance their scientific process skills (KPS) and conceptual comprehension (Yulasti et al., 2018). Process skills are important in science because they combine knowledge and psychomotor abilities to solve issues (Arumningtyas, 2022). Through the simulations given, the virtual lab or PhET application may provide actual learning experiences so that students can comprehend and participate in the learning process (Alatas & Sakina, 2019). The utilized problem is the problem of energy change, which is now becoming increasingly prominent on a global scale, with nations worldwide planning to migrate from long-renewable energy to cost-effective renewable energy such as solar, wave, wind, and other energy.

The amount of energy contained that is presently consumed by society on a daily basis is thought not to make the earth more habitable; rather, the energy that has been used makes the earth very unfit for human habitation in terms of atmospheric quality, water quality for daily needs, and the potential for dangerous energy that cannot be handled, such as nuclear and its residues. As a result, it is critical for every community to limit the use of non-environmentally friendly energy in a variety of methods, including teaching or understanding and socializing changes in energy consumption at a young age, such as in schools. Because every lesson in school is meant to study the causes of issues and search for and develop viable remedies that may be applied, schools are the most effective venue for instruction regarding many types of changes.

Students improve their knowledge and process abilities when they use PhET simulations aided by LKPD in physics instruction (Novebrini et al., 2021). Students' intellectual along with sensorimotor comprehension can be improved by learning created utilizing a student-centered learning approach supplemented by virtual laboratories. Students' cognitive abilities can be developed through the use of learning media, such as laptops or computers that support virtual laboratory learning, while students' psychomotor abilities can be developed through the use of learning media, such as laptops or computers that support virtual laboratory learning (Xhafa et al., 2010). With the teacher's direction and conditioning of the classroom environment, students will be instructed to use the information they get

to understand and combine it into excellent and proper conceptions.

Students can acquire information directly by combining technology with carefully constructed learning from the teacher (Septaria, 2019). Before being incorporated in learning, technology should be investigated by the instructor in order to make it simpler for students to absorb the information presented and to avoid conceptual mistakes in learning (Septaria et al., 2022; Yahya, 2014). Often, technology or learning resources circulating on the internet lead students to believe that they are true without cross-checking the validity of the source and the truth of the concepts used, resulting in students having a faulty understanding of the concept, which becomes more difficult to correct the longer they believe it to be true (Bozkurt Altan & Tan, 2020). From another perspective, students are advised to be able to study from a variety of sources, including textbooks, technological devices, or others.

Students' instructional materials are increasingly concerned with functionality and convenience of access (Safirah et al., 2022). Currently, the most often utilized learning tools by students are those that originate from the internet and include virtual elements to make them feel more genuine. Implementing learning through virtual laboratories based on research findings has a good impact on student accomplishment, as student comprehension is based not only on their information but also on their abilities (Nafrianti et al., 2017). Teachers' instruction should not only enhance students' hard abilities, but also acquire soft abilities that students will

need in the future, as well as mastery of technology. This is consistent with study by (Putri et al., 2018), which found that learning tools loaded with PhET can increase students' soft skills, particularly their science process abilities. This demonstrates the efficacy of the PhET-assisted learning technique in improving students' science process abilities.

Based on evaluation of performance observations using five indicators as a reference in assessment. Observing, categorizing, understanding, communicating, and concluding are the five indications. The indication with the highest percentage is observing and categorizing, in which students can quickly classify the data collected after witnessing the simulation provided, and then interpret the data. In PhET, students examine numerous energy sources such as solar light energy, heat energy, and water energy, as well as the conversion of energy sources to other forms of energy such as electrical energy, motion, and others. However, students have decreased scores during this level because they prefer to just interpret data that they are acquainted with every day without first remembering the new phrases they have acquired, therefore students are not ideal in recording the intensity of incoming and exiting energy.

The second sign is that they convey the facts and determine that they have an average score, where students develop their abilities through group discussions, which are then finalized and presented individually in front of the class. During the discussion, students receive feedback or correction from their peers. The signs that have not been fully improved are in student interpretation, where pupils are still unable

to evaluate in depth the first energy sources they have. The intended interpretation is that students can understand the fundamental principles of energy sources, such as the one depicted in Figure 2 below:

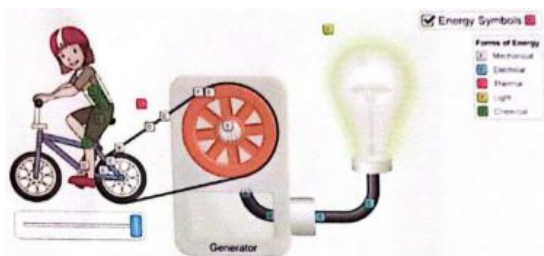


Figure 2. Simulation of energy changes in PhET

In Figure 2, it is intended that students will be able to grasp the notion of energy sources from individuals who can move because they acquire additional energy sources in the form of food, which is converted by the human digestive system into ATP, ADP, or NADH⁺. However, pupils continue to struggle with this notion.

CONCLUSION

Based on the information presented earlier, the subsequent conclusions may be proposed: According to the hypothesis test, there is a substantial impact of the PhET-assisted experimental learning technique on the science process abilities of students in science topics on energy changes, with a significance of 0.000 0, 05. Students' Science Process Skills can be improved by using PhET-assisted experiential learning approaches. This is evidenced by enhanced pretest and posttest results on cognitive and performance tests in the moderate range. Furthermore, the PhET-assisted experiential learning approach has a considerable impact on science process skills, with a cognitive test N-gain value of

0.64 indicating an increase in the medium category and a performance test N-gain value of 0.75 indicating an increase in the high category.

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