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Digitalization of Physics Education Using Virtual Laboratory

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Abstract: Investigations examining the impacts of virtualizing physics instruction use students in class XII's second semester as the research subjects. Due to a lack of resources or infrastructure to support the prior practicum, this research will focus on how students learn physics utilizing the Virtual Laboratory. Also, it will provide a general picture of how students behave during in-class instruction. Teachers are encouraged to use technology-based learning aids in increasingly inventive ways in order to make learning more engaging and efficient. Descriptive data analysis is utilized in this type of study to conduct qualitative research. According to the study of the researcher's data and evaluations of prior studies, PhET simulations may be created to help students project abstract physics information in a way that makes it simple for them to comprehend.

Keywords: PhET simulation, physics instruction, and virtual laboratories.

Introduction

Education is the practice of communication and learning, which also entails the sharing of information (Mardiani, 2023). Education is more than just teaching: it involves the transfer of knowledge, the transformation of values, and the growth of the individual (Sumaryanti, 2023). Every educational activity needs techniques, methods, and teaching aids that can encourage students to see educational endeavors favorably (Risnofiardi, 2023). This is done to promote student achievement and guarantee that the national education goals are met.

Understanding ideas is the most crucial aspect in the physics teaching and learning process (Maison et al., 2020). However, because not all pupils have the same aptitude to absorb topics, they are prone to mistakes. As a consequence, the notions developed by students will differ from those previously developed by specialists (Djanette & Fouad, 2017; Irwansyah et al., 2018; Yang & Lin, 2015). This is what leads these kids to be deemed to have misunderstandings (Kaltacki-Gurel et al., 2018; Peşman & Eryılmaz, 2015). Misconceptions are persistent patterns of thinking in diverse issues that differ from the thinking patterns of experts (Didik et al., 2020; Didik & Wahyudi, 2021). Misconceptions are more common among pupils who have a lesser level of analytical skills. Because every physics idea is connected to another, students with advanced analytical skills are required (Kaltacki-Gurel & McDermott, 2017).

When studying physic science, students must become used to carrying out the traditions of scientific work as scientists work (Ko'o et al., 2022). Experimentation is one of the traditions of scientific activity that may be carried out (Rahayu et al., 2022; Siregar et al., 2013). Experimental activities must be carried out to improve students' physics ideas that have been given by the instructor during learning in order to lower the amount of student misunderstandings (Didik et al., 2020). The experimental material must be the same as the content delivered by the teacher so that the experimental and learning materials complement each other.

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The majority of instructional materials encourage students to engage in exploratory activities that further society's educational objectives, as is the case with learning science (Kristianto, 2023). Students just pay attention to the teacher's explanations and are only concerned with whether the subject has been finished, paying little regard to the significance of student involvement. The teacher's position is still comparatively prominent in learning activities. Students are consequently just able to memorize topics rather than completely comprehend them, which restricts their comprehension of the theoretical notions (Gare et al., 2022).

Abstract topics are covered in physics education. In contrast, the study of physics involves precise calculations and the study of natural science. The numerous branches of research in physics differ in a number of ways (Dede, 2022). Calculations in physics must be performed accurately to avoid mistakes when answering questions, carrying out practical work, and performing calculations.

According to the findings of interviews with physics teachers at MAN 1 Yogyakarta, students typically behave passively during the learning process because they are deprived of the chance to participate actively and directly in the learning process, which favors the teacher's dominance over the students'. However, the only methods used in physics instruction at schools are lecture-based learning techniques, reading books, and practice questions. As a result, learning is not as effective as it may be.

PhET Interactive Simulation (Fatimah & Suryandari, 2022) is one of the most extensively utilized virtual laboratories nowadays. PhET is presently frequently utilized since, in addition to offering many different sorts of practicum, it is also relatively simple to apply for (Abdjul & Ntobuo, 2019). Practicum employing PhET can have varying effects on concept mastering, learning outcomes, and students' problem-solving ability (Riantoni et al., 2019). This is because learning through practicums utilizing PhET can explain abstract topics in a short period of time (Silviyani, 2020). As a result, the community service organized community service activities to promote the PhET Interactive Simulation virtual laboratory as an alternative to practicum activities at school.

Interview and observation findings show that teachers are still looking for the best instructional media to employ while teaching physics, particularly for content that is challenging for pupils to project. When conducting interviews with teachers, they particularly wanted to get to know the PhET simulation learning medium because the use of PhET learning media is a new learning medium in general.

Materials and Methods

In this study, descriptive data analysis is used in qualitative research. Researchers observed and spoke with teachers prior to the PhET program's implementation with students in the classroom. They then conducted use trials to ascertain how long it would take to alter the number of lesson hours available while also validating the research instruments.

This research was carried out in 2 stages, namely the introduction and use stages. The introductory stage is to introduce the PhET simulation as well as the operational steps that must be carried out by students, thereby minimizing students' errors and difficulties in learning. Meanwhile, in the use stage, students carry out a practical simulation according to the steps explained by the researcher.

Results and Discussion

Results

Practice is a learning strategy for physics that is simpler for students to adopt. Students benefit from physics laboratories because they provide them the freedom to practice whenever and wherever they choose. Internet resources that are available at all times and from any location. As a result, everything will be simpler for everyone, especially in the field of education. Participation online has a number of further advantages. Because work is increasingly done online or on online platforms, systems are no longer bound to

one area and can only be accessible from particular places or with certain devices.

Virtual learning environments can increase students' enthusiasm in studying physics subject. Other educational tools, such as e-modules and e-learning, can be utilized in physics in addition to virtual laboratories. Different types of instructional resources are also available for students to use. Animated learning materials, audio learning materials (Voice Notes), audio-visual learning materials (Vidio), audio learning materials, and print learning materials all incorporate instructional games. Some of these educational tools help pupils study physics and comprehend information no matter where they are. Interesting and simple-to-use learning materials help students concentrate better and assimilate information more rapidly.

Researchers have found that using learning media in the teaching and learning process has several advantages, including keeping the delivery of topics consistent so that students are not bored with the same media or methods, increasing interest and improving the effectiveness of the learning process, and saving time and energy for both education and students.

Discussion

Researchers' field data demonstrates that the creation of a number of new instructional resources can aid in fostering students' enthusiasm in their studies. In order to pique their interest and facilitate their learning, teachers might utilize these instructional materials as a source of knowledge for their pupils. Technology makes it simple for teachers to provide a variety of engaging and innovative learning resources, which raises students' interest in physics-related courses.

This is determined by how students accomplish their educational tasks, which determines whether they pass or fail. The process will go smoothly if the instructor, students, environment, and learning facilities all work together. The stronger the student's starting ability level before to studying the future physics topic, the better the student's learning results will be, according to data gathered from a field evaluation by researchers. Students who can successfully use technology tools and who have a genuine desire to study are also advantages. Therefore, pupils that chose physics as their topic of interest will project the content more.

However, traditional learning models, particularly direct learning models that use the lecture approach, continue to dominate the modern physics learning process. The absence of sufficient physics laboratory equipment in schools, both in terms of number and quality, is the primary cause of instructors' continued reliance on traditional teaching techniques. Inaccurate measurement findings are produced by low-quality lab equipment, making it unable to use the data properly to develop concepts or hypotheses. The features of the physical material itself, which includes abstract processes and notions that cannot be observed physically, enable experimental activities to be conducted either in real time in a laboratory or virtually in a virtual laboratory.

According to the findings of study evaluations made by researchers, using animation to aid students in understanding the learning process is one of the suggested methods. As a result, physics may be taught via multimedia-based information and communication technologies. Virtual laboratories have a lot of benefits. One of his skills is the capacity to convey intricate ideas that cannot be properly articulated orally.

Researchers are digitalizing learning by creating a virtual laboratory to conduct tests that can't be performed physically. A PhET simulation is one kind of virtual laboratory. A group from the American University of Colorado created this virtual laboratory. To aid pupils in understanding visual ideas, PhET was created. PhET simulations use pictures and simple tools like radio buttons, sliders, and click-and-drag manipulation to make the unseen apparent. PhET simulations are simple to use and work well in a classroom setting. The use of website-based virtual laboratories on the internet, which can be accessed for free and are simple to use, has been proven to help students by improving their understanding of abstract concepts of physics material, which are typically difficult for students to grasp. both within and outside of the classroom.

The practicum process through the virtual laboratory that was developed can facilitate

students to be more active. Through virtual laboratories, students are accustomed to thinking and being actively involved in virtual hands-on. This virtual hand on is an actual replacement of equipment through simulation. The characters and equipment in the virtual laboratory are made almost the same as real equipment. By doing it directly and by introducing the material first, carrying out experiments with a virtual laboratory is expected to reduce the level of student misconceptions. Implementing learning by combining theory and experimentation can increase students' level of analysis so that they can build conceptual thinking analysis in accordance with the conceptual thinking of experts.

The use of virtual laboratories at this school is supported by adequate internet facilities. So there are no obstacles in carrying out virtual experiments through PhET Interactive Simulation. The advantage of using PhET in learning is the availability of PhET which can be accessed from anywhere and using any device. This will make it easier for teachers to learn by applying theory and experimentation at the same time. So it is hoped that students will be able to understand complex physics concepts well and correctly. Learning using juxtaposed theory and experiment can improve students' abilities in analysis because carrying out experiments themselves is proof of existing physical theory (Safarati et al., 2022). Without this ability, there will be a greater possibility for students to experience misconceptions (Astuti et al., 2017; Kustiarini et al., 2019). After the introduction of the PhET Interactive Simulation virtual laboratory as an alternative to practical activities in The Riyadh Overseas International School was carried out online via the Microsoft Teams application and carried out evaluation and reflection through distributing questionnaires to students regarding service activities. There are two evaluations, namely the ability of the resource person and the implementation of the activity. Evaluation of the resource person's abilities includes delivery of material, mastery of material, interaction with participants, interesting atmosphere and ability to answer questions.

Things that are evaluated in the dedication to introduce the PhET Interactive Simulation virtual laboratory as an alternative practicum activity at this school include student enthusiasm, application difficulty level, application facilities, training time and method of delivering the material. As for the results of the participant evaluation questionnaire, it appears that the introduction of the PhET Interactive Simulation virtual laboratory as an alternative practicum activity had a positive impact on academic improvement. However, in every activity there will always be criteria that need to be improved. There are two criteria that have a poor response, namely training time and the level of difficulty of using the application. The training time provided is still inadequate so there is still some physics material that cannot be discussed in the virtual practicum model.

However, research to introduce the PhET Interactive Simulation virtual laboratory as an alternative practicum activity in schools can be said to have been implemented quite well. This is shown by the high level of enthusiasm of students during training. The students' response to the presenters was also good as shown by the questionnaire evaluation which was in the very good category. Apart from that, students' motivation during the training is also in the very good category

Conclusions

Learning is considerably facilitated by integrating simulation-based technology, or PhET, in educational activities. such involves the creation of instructional physics resources based on the Virtual Lab. The use of learning media in the physics learning process offers a number of advantages, such as consistency in the presentation of lesson information to prevent students from becoming bored since employing the same media or approaches makes the learning process more enjoyable, effective, and efficient. In addition, PhET simulations can assist students in understanding abstract physics subject by helping them picture it.

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