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IMPLEMENTATION OF THE USE OF PHET SIMULATION TO FACILITATE STUDENTS' PHYSICS LEARNING ON WAVE MATERIAL

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Abstrak

Fisika dengan berbagai konsep yang masih sulit dipahami, membutuhkan media pembelajaran yang dapat menjelaskan konsep tersebut dengan lebih mudah dan menarik. Keterbatasan media nyata menjadi kendala dalam penerapan pembelajaran virtual, sehingga guru membutuhkan media digital sebagai alternatif, salah satunya adalah Simulasi PhET. Penelitian ini bertujuan untuk mengeksplorasi penggunaan Simulasi PhET dalam memfasilitasi pembelajaran fisika siswa pada materi gelombang. Penelitian ini menggunakan pendekatan kualitatif dengan metode deskriptif. Hasil yang diperoleh menyatakan bahwa Simulasi PhET dapat meningkatkan pemahaman konsep siswa, keterampilan eksperimen, dan hasil belajar kognitif. Dengan demikian, penerapan Simulasi PhET dalam pembelajaran fisika pada materi gelombang sangat bermanfaat untuk secara signifikan meningkatkan pemahaman konsep fisika karena simulasi ini menghubungkan konsep abstrak dengan fenomena nyata yang sulit diamati secara langsung, melatih keterampilan proses sains siswa, dan simulasi ini dapat membuat pembelajaran fisika pada materi gelombang lebih efektif, menyenangkan, dan dapat diakses kapan saja tanpa keterbatasan alat praktikum fisika.

Kata Kunci: Gelombang, Simulasi PhET, Pembelajaran Fisika.

Abstract

Physics with various concepts that are still difficult to understand, requires a learning media that can explain the concept more easy and interesting. The limitations of real media are an obstacle in implementing virtual learning, so teachers need digital media as an alternative, one of which is PhET Simulation. This study aims to explore the use of PhET Simulation in facilitating students' physics learning on wave material. This study uses a qualitative approach with a descriptive method. The results obtained state that PhET Simulation can improve students' understanding of concepts, experimental skills, and cognitive learning outcomes. Thus, the implementation of PhET Simulation in learning physics on wave material is very useful for significantly improving the understanding of physics concepts because this simulation connects abstract concepts with real phenomena that are difficult to observe directly, trains students' science process skills, and this simulation can make physics learning on wave material more effective, fun, and can be accessed at any time without the limitations of physical practicum tools.

Keywords: *Waves, PhET Simulation, Physics Learning*.

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INTRODUCTION

Rapid technological developments have brought significant changes to all aspects of life, with the emergence of the phenomenon of digitalization. This phenomenon permeates all aspects of human life, including business, government, education, health, socio-political aspects, and family life (Irfatin et al., 2024). The dominant reliance on technology today is on Generation Z and the Alpha generation. This reasoning is supported by research Regiani et al (2023). Which states that children have easier access to digital devices and the internet than previous generations. Inappropriate use of technology in the field has negative impacts, such as dependence on digital devices among various groups, including students.

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Research Nurwita et al (2019) at Pamulang Regional Junior High School (SMP Daerah Pamulang) found that students' dependence on social media can disrupt study time and reduce their enthusiasm and learning outcomes. Therefore, dependence on social media can negatively impact the learning process and student learning outcomes.

The learning process is crucial. Learning is a process, and the learning method is key. Therefore, active student participation is essential for achieving meaningful learning. Based on observations at SMA Kolombo Sleman, conventional learning media demonstrated in front of the class were less engaging for students. Furthermore, the limited quantity of learning media also hindered student focus. Some students were preoccupied with using their phones to browse social media or play online games. This resulted in a lack of student participation during the lesson. Furthermore, the teacher-centered learning approach and the lack of practical tools also reduced student motivation and participation in the learning process, necessitating the implementation of technology in learning.

The use of technology in education has a significant impact on efforts to provide quality and equitable education. In physics learning, teacher-centered teaching methods and a lack of practical tools make it difficult for students to understand complex material such as waves. This is consistent with research findings Azizah et al (2020), which found that the biggest problem faced by students in physics learning is misunderstandings that often arise during the learning process. This occurs because educators only teach abstract physics concepts in the classroom, without complementing the learning with laboratory experiments. Therefore, the need for visualization of abstract concepts using assistive technology, especially in wave material.

According to Khunaeni et al (2020)visualizing concepts can help construct knowledge and facilitate student understanding. Visualizing physics concepts, such as waves, through videos and simulations can help students better understand the material. Wave physics should be a fun topic to learn because it is so familiar to us. However, we know that wave material is quite difficult to observe. Therefore, many students have difficulty mastering the concept of waves because it is abstract. Therefore, the implementation of assistive technology is necessary to facilitate students in this wave material.

PhET Simulation is a learning technology solution that can bridge this gap. Using this medium, students can conduct virtual experiments, observe changes in parameters such as frequency and amplitude in real time, and visually see their impact on waves. This not only facilitates conceptual understanding but also increases student engagement in the learning process, making learning more pleasant and effective.

LITERATURE REVIEW

Learning is a process of interaction between students and educators and learning resources in a learning environment (Azani, 2024). Physics is the science that studies natural phenomena and their interactions (Wea et al., 2021). This science encompasses the study of various natural events and phenomena, both on the micro and macro scales. Physics seeks to understand how the universe works, from subatomic particles to vast galaxies, and attempts to find connections between these events and existing empirical facts. On the micro scale, physics explores the world of elementary particles, atomic and molecular interactions, and quantum phenomena that underlie many modern technologies, such as computers and lasers. On the macro scale, physics studies planetary motion, the properties of matter under various conditions, and the laws that govern the universe, such as gravity and electromagnetism.

The selection of a learning model or method must be tailored to the characteristics of the material being taught. Simulation is a training method that mimics something in a form that closely approximates real-world conditions. This simulation represents a system or process using statistical models or actors for demonstration (Hasbullah, 2021). A simulation model is a learning method that allows students to experience or sense an event or occurrence that will be taught in the learning process (Fitriyati & Prastowo, 2022). The simulation learning method can be applied as a teaching method, assuming that not all learning processes can be carried out directly with real objects (Hasbullah, 2021). The simulation method is a learning method that encourages students to directly experience using non-real media. One of the goals of the simulation method is to increase student engagement (Hasbullah, 2021).

By using simulation models, students can actively participate in learning. Simulation models are computer-based learning models that deliver material through simulations, usually in the form of animations. Simulation models are learning methods that use computers to deliver material through simulations, often presented in the form of animations (Fitriyati & Prastowo, 2022). One important topic in physics with widespread application in everyday life is waves. Waves are propagating vibrations, so the position of the wave's deviation can also be expressed in terms of phase. The topic of waves covers various concepts such as wave phase difference, wave principles, frequency, amplitude, velocity, and wave interference. Waves are an important topic in physics, involving concepts such as frequency, amplitude, velocity, and wave interference. A deep understanding of waves requires appropriate visualization and experimentation (Khunaeni et al., 2020).

Digital-based learning media has developed and plays a role in the physics learning process, one of which is the virtual laboratory. This virtual laboratory is interactive multimedia with a series of laboratory equipment in the form of (virtual) software, operated using (real) computer hardware and capable of simulating actual laboratory activities. One such virtual laboratory used globally is the PhET simulation, developed by the University of Colorado. PhET Simulation is a research-based interactive simulation software developed by the University of Colorado Boulder. PhET Simulation is a simulation designed by the University of Colorado that discusses concepts in physics, biology, and chemistry. PhET

simulation is a learning media simulation that contains animations that can solve problems in physics such as vectors, kinematics, parabolic motion, and free fall (FFL) (Mahardika et al., 2022).

Research Verdian et al (2020) found that learning using PhET media is more effective in practice than relying on real-life lab work. This is because visual media allows students to more actively represent the material they are learning. It also allows teachers to more easily convey meaning and format the learning delivered. This aligns with the opinion of Arifin et al (2011) that using PhET simulations makes students more active and enthusiastic in participating in learning because PhET simulations have a unique and attractive appearance. Based on this research, student learning outcomes using PhET simulations experience greater improvement and can improve students' critical thinking skills.

Another advantage of using PhET is its ability to illustrate abstract phenomena in physics that are difficult to observe directly with human senses, making them possible through simulation(Badriyah et al., 2023). Despite PhET's simplicity and flexibility, this simulation still emphasizes the cognitive aspects that are central to learning. The alignment between concepts and applications is directly proportional, preventing misconceptions in learning(Dasmo et al., 2019).

METHOD

This study employed a qualitative approach with a descriptive method. Data collection in this study involved observation, interviews, and documentation analysis. First, observations were conducted by directly observing the interaction between teachers and students, the level of participation, and students' responses to the learning materials. The purpose of these observations was to directly understand how learning occurs. Second, interviews were conducted to determine the previous learning conditions. Third, document analysis was conducted on documents related to learning, such as student assignments.

RESULTS AND DISCUSSION

Observations and interviews with students and physics teachers in grade XI F1 at SMA Colombo Sleman indicate that physics is considered a difficult subject. This difficulty stems from the complexity of physics material, which combines understanding of natural science and mathematics. Furthermore, the availability of practical tools at school is inadequate to facilitate students' real-world experiences in abstract theoretical learning. Therefore, it is crucial to implement physics instruction in schools that is geared toward students' conceptual understanding of the natural world, prioritizing practical applications and real-world experiences.

Physics learning in schools is directed at students' conceptual understanding in accordance with the needs of changing student mindsets and the demands of the times, which require a responsive learning approach and the use of modern technological tools to improve learning effectiveness. Evidence from various studies shows that technology-based educational tools significantly improve learning levels, positive attitudes towards learning, engagement, student motivation, and assessment performance in various educational environments. One method used for real-life experiences in abstract physics learning such as wave material is through digital simulation as a form of technology integration in 21st-century learning. The digital technology that is suitable for implementation in wave material is PhET Simulation, by using PhET Simulation students will find it easier to understand concepts, increase active student involvement in the learning process, so that learning becomes more enjoyable and effective.

Based on the analysis of observation data, it shows that the use of PhET Simulation can encourage students to participate more actively, because the use of PhET Simulation technology facilitates students to better understand the concepts taught with practical experience based on parameters that can be varied. The data from the practical experience is observed so that a constructive understanding is formed, which has previously been explained by the teacher mathematically in class and then strengthened by simulation as a form of practical experience, to obtain a meaningful learning experience. By using PhET Simulation technology, students participate more actively in learning activities, both in class discussions and in conducting virtual experiments.

Based on the implementation results of the use of PhET Simulation technology, it is proven to improve students' conceptual understanding, experimental skills, and cognitive learning outcomes. This success is supported by high interactivity features and mathematical abstraction visualization capabilities. Thus, the implementation of PhET Simulation in learning physics on wave material is very useful for significantly improving the understanding of physics concepts because this simulation connects abstract concepts with real phenomena that are difficult to observe directly, trains students' science process skills, and this simulation can make learning physics on wave material more effective, fun, and accessible at any time without the limitations of physical practicum tools.

CONCLUSION

Based on the overall observation results, the implementation of PhET Simulation in learning physics on the topic of waves shows an increase in student understanding and participation. PhET Simulation is effective in helping students understand abstract physics concepts and increasing student engagement in learning, while still taking into account the needs and conditions of students.

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