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The Influence of the Anchored Instruction Model assisted by PHET on Students' Problem Solving Abilities

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Abstract
This research aims to test the effect of the anchored instruction model assisted by PhET on students' physics problem solving abilities in optical instruments at SMAN 1 Sukamulia. The type of research used is quasi experimental with a pretest-posttest control group design. The population is all students in class XI MIPA SMAN 1 Sukamulia, totaling 52 people. The research sample was taken using a saturated sampling technique and class XI MIPA 1 was selected as the experimental class and class XI MIPA 2 was selected as the control class. The experimental class was treated with an anchored instruction model assisted by PhET and the control class was treated with a direct learning model. The research instrument consists of a problem solving ability test (KPM) in the form of a description test of 10 questions taking into account validity, reliability, level of difficulty and differentiability of questions. The KPM pre-test and post-test data were tested for normality and homogeneity, then continued with hypothesis testing using the twin sample t-test. Hypothesis test results obtained that the calculated t value was greater than the t table, so Ha was accepted, so that the PhET-assisted anchored instruction learning model had an effect on ability. Physics problem solving for students at SMAN 1 Sukamulia.

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INTRODUCTION

The 21st century brings various new challenges requiring more complex skills and competencies. One of the crucial competencies that is increasingly important is problem-solving ability. In this era of globalization and continuously evolving technology, this ability is essential not only for individuals but also for organizations and society as a whole (Afdareza et al., 2020; Belecina & Jose M Ocampo, 2018). Problem-solving ability involves identifying problems, gathering relevant information, analyzing data, and developing effective solutions. This process includes several critical steps such as clearly recognizing the problem and understanding its context, gathering relevant data and information to understand the problem thoroughly (Hulyadi, Muhali, & Gargazi, 2023), analyzing the collected data to find patterns, causes, and effects of the problem, developing various innovative and effective alternative solutions, implementing the chosen solution with a well-planned strategy, and evaluating the effectiveness of the solution and making revisions if necessary (Anazifa & Djukri, 2017; Carlgren, 2013).

Problem-solving skills have become a fundamental competency that students must possess amidst the complexities of problems and challenges in the 21st century. The problems faced in the 21st century are often complex and dynamic, requiring a more flexible and adaptive approach (Almazroui, 2023). Technological advancements accelerate changes and demand the ability to adapt quickly to new situations (Afdareza et al., 2020). Global interaction and interconnection create problems involving various countries and cultures, requiring cross-cultural understanding and universal solutions. According to Akpur (2020) and Birgili (2015), problem-solving skills foster creativity and innovation, which are key to surviving and thriving in a competitive environment. High-level thinking skills are a major component in mastering problem-solving abilities. Critical, analytical, and logical thinking skills are fundamental competencies that students must have to be adaptive and creative in finding solutions to every problem they face (Hulyadi et al., 2024). The ability to generate new ideas and see problems from different perspectives becomes easier if one possesses high-level thinking skills. Problem-solving ability is an essential competency in facing the challenges of the 21st century. With the ever-evolving complexity and dynamics of problems, individuals and organizations need to develop this skill to remain relevant and competitive. Effective education, training, and collaboration are keys to enhancing problem-solving abilities in all sectors of life.

Science is the foundation of human knowledge about the universe and life. Through the scientific method, we can understand natural and social phenomena, as well as develop technologies and solutions for the challenges we face. By continuously supporting scientific research and education, we can ensure the progress and welfare of humanity in the future. Science, as a concept derived from a series of scientific work in nature and laboratories, requires problem-solving skills to master its concepts more comprehensively (Saputra et al., 2019). Physics is a branch of science that focuses on the study of matter, energy, and the relationship between them, meaning students not only need to understand physics material but also be able to relate it to various problems encountered in everyday life (Gunawan et al., 2015). One of the factors in mastering science is having the ability to solve problems (Silamon et al., 2020). According to Sabaruddin (2019), problem-solving ability is an important part of learning physics and a way to gain better and faster knowledge. Students learn how to apply the knowledge they have acquired correctly and help them solve problems in more detail.

Improving problem-solving skills needs to be supported by appropriate and innovative learning models to achieve educational goals. Innovative learning models are important because they help students acquire the necessary skills in an increasingly complex and rapidly changing world and help students learn more effectively by enhancing their participation in the learning process and providing meaningful real-life learning experiences (Salamun et al., 2023). However, the implementation of learning models alone is not enough to enhance problem-solving skills because physics learning includes some abstract materials, one of which is Optical Instruments. If the explanation is not supported by good media, students will face obstacles due to differences in abstract thinking abilities and imagination power among students (Sari et al., 2018). Additionally, in physics learning, students need to conduct practicals as an implementation of the material applied in real conditions (Purwoko, 2018). However, not all practicals can be performed in a real laboratory, not only due to the unavailability of equipment but also because the characteristics of physics materials involve processes and abstract concepts that cannot be directly observed (Medica et al., 2021). Therefore, media is needed as a substitute for laboratory experiments, such as the use of virtual laboratories.

Based on observations and interviews conducted by researchers with physics teachers at SMAN 1 Sukamulia, East Lombok Regency, physics learning uses a direct learning model. With the implementation of this learning model, it was found that the learning outcomes of class XI MIPA students were still not optimal. The average score for the End of Semester Exam

(UAS) in physics from 52 class XI MIPA students was 60.75. Many students have not yet achieved the minimum competency standards. These learning outcomes reflect the poor problem-solving skills of class XI MIPA physics students at SMAN 1 Sukamulia, caused by students' difficulty in understanding abstract concepts and formulas, especially in formula derivation. The difficulty in understanding abstract physics concepts is often due to the lack of use of additional learning media that can assist students in practical implementation. Moreover, the use of practical methods in physics learning at schools is rarely conducted due to the limited availability of tools and materials for practicals. Teachers only conduct practicals depending on the availability of equipment and materials for a particular topic. This situation makes students less interested in attending physics classes.

To address these challenges, an innovative learning model and media are needed. One such model is the anchored instruction model. Anchored instruction is one of the learning models suitable for 21st-century development as it involves technology in learning in the form of interactive multimedia (Hollil et al., 2022). Anchored instruction embeds all the information needed to solve problems, facilitating learning with limited time and resources (Kuntadi et al., 2016). The information required in problem-solving is presented in the form of anchors (which can be videos or other interactive multimedia) and emphasizes the use of multimedia, particularly visual media (Setiawan et al., 2020). The advantages of the anchored instruction model include enabling students to find problems on their own, developing students' deep understanding, and enhancing collaborative, cooperative, and negotiation skills (Hafizah et al., 2014).

Anchored instruction learning requires media as it is a technology-based learning model and emphasizes meaningful problem-solving that aligns with real-world contexts (Siahaan, 2020). According to Rizaldi et al. (2020), one media that can be used to help students understand abstract concepts in physics is PhET (Physics Education Technology). PhET is an application that provides virtual practicals used in learning (Jamila, 2023). The use of PhET media in learning aims to help clarify concepts, make it easier for teachers to deliver materials, thereby improving time efficiency, and provide space for students to actively participate, making learning more enjoyable (Alfiah & Dwikoranto, 2022). In summary, problem-solving skills are fundamental competencies required in the 21st century, especially in science education. Innovative learning models like anchored instruction, supported by media such as PhET, play a crucial role in enhancing these skills. These tools help make abstract concepts more tangible, encourage active student participation, and bridge the gap between theoretical knowledge and practical application. By integrating such models and media into the curriculum, educators can significantly improve students' problem-solving abilities and overall understanding of scientific concepts.

METHOD

This research is a quasi-experimental research with a research design, namely pretest-posttest control group design. The population of this study was all students in class XI MIPA SMAN 1 Sukamulia with a sampling technique using saturated samples. Class XI MIPA 2 became the control class by applying the conventional learning model, while class The research instrument used was a test question consisting of 10 descriptive questions to measure the physics problem solving abilities of students who were given anchored instruction model learning assisted by PhET. The prerequisite tests applied include a homogeneity test using the F test method and a normality test using the chi square test method. Data analysis will be carried out using a twin sample t-test.

RESULTS

This research aims to test the effect of the anchored instruction model assisted by PhET on the physics problem solving abilities of students at SMAN 1 Sukamulia. The ability measured is problem solving ability which consists of four indicators. Problem solving ability tests are given before and after treatment. The instrument uses 10 validated problem solving ability questions. Data about the results of students' abilities before and after treatment was obtained through pre-tests and final tests. Based on the initial test and final test, it can be seen that there has been an increase in the problem solving abilities of both classes as shown in Table 1.

Table 1. Average Score Obtained for Experimental Class and Control Class

Class	Competention	Average	Category
Experiment	Beginning	19.55	Very low
	End	79.62	Tall
Control	Beginning	19.70	Very low
	End	73.91	Tall

Based on Table 1, it can be seen that the average initial ability value for the experimental class is 19.55 while the control class is 19.70, then the final average ability value for the experimental class and control class is 79.62 and 73.91 respectively. The results of the tabulation of scores and calculations of the initial test and final test of students' problem solving abilities for each indicator of problem solving abilities (IPKM), are shown in Table 2.

Table 2. Percentage of Average KPM Scores for Experimental Class and Control Class Students

Class	Test	Average Problem Solving Ability Score (%)							
		IKPM-1	Category	IKPM-2	Category	IKPM-3	Category	IKPM-4	Category
Experiment	Beginning	43.91	Currently	8.85	Very low	12.64	Very low	12.30	Very low
Control		46.09	Currently	10.00	Very low	12.61	Very low	8.55	Very low
Experiment	End	79.89	High	81.26	Very high	76.90	High	76.90	High
Control		76.52	High	75.94	High	72.03	High	71.45	High

Based on Table 2, it is known that the percentage of the average value of the problem solving ability of students in the experimental class and control class for each indicator has increased after being given treatment. The percentage of the average score in the initial test of problem solving ability of experimental class and control class students in IKPM-1 is classified as moderate, while in IKPM-2, IKPM-3, and IKPM-4 it is still classified as very low.

Data testing begins with testing the homogeneity of the data and normality of the initial and final test data, then determining the type of t-test to be used. Based on the initial test data obtained, it shows that Fcount < Ftable, namely 1.05 < 1.93, so the two samples are said to be homogeneous. In the final test it was also seen that Fcount < Ftable, namely 1.42 < 1.99, so the two samples were said to be homogeneous. The results of the data normality test also show that χ2count < χ2table, where in the initial test it was 7.24 < 16.91 for the experimental class and

7.48 < 16.91 for the control class so that the data was normally distributed. In the final test it was also seen that χ2count < χ2table, where for the experimental class it was 6.08 < 16.91 for the experimental class and 4.91 < 16.91 for the control class, which means the data was normally distributed. The prerequisite hypothesis test has been analyzed and then a hypothesis test is carried out. The hypothesis test used is a parametric statistical test, namely the twin sample t-test. The results of statistical tests (t-test) show a value of t = 2.05. This price is greater than the price ttable = 2.00 at a significance level of 5%, this shows that there is an influence of the anchored instruction learning model assisted by PhET on the problem solving abilities of students at SMAN 1 Sukamulia.

To determine the quality of improving students' physics problem solving abilities, data was grouped on improving students' problem solving abilities based on the normalized gain interpretation for each class. The composition of the normalized gain interpretation is presented in Table 3.

Table 3. N-gain Value of Problem Solving Ability Indicator

Indicator	Experimental Class				Control Class			
	Amount Post-test	Amount Pre-test	N-gain	Category	Amount Post-test	Amount Pre-test	N-gain	Category
Recognizing Problems	382	695	0.64	Currently	318	528	0.57	Currently
Planning Strategy	77	707	0.79	High	69	524	0.73	High
Implementing Strategy	110	669	0.74	High	87	497	0.68	Currently
Evaluating Solutions	107	669	0.74	High	59	493	0.69	Currently

Table 3 above shows the increase in students' physics problem solving abilities in each class in each indicator. The N-gain of the experimental class's problem-solving ability is in the high category, while the N-gain of the control class's problem-solving ability is in the medium category. Researchers also used the N-gain test to determine the extent of improvement in problem solving abilities per indicator in the experimental class and control class. In IKPM-1, IKPM-2, IKPM-3, and IKPM-4 the experimental class had a higher increase in N-gain score than the control class.

DISCUSSION

Based on the results of the average pre-test problem-solving skills score percentage per indicator of students, it was found that IKPM-1 for the experimental and control classes was almost the same. However, for IKPM-2 (planning strategies), the control class scored higher than the experimental class. This was because students in the control class attempted to write down the equations used to solve the given problems, even though the equations were incorrect, whereas the experimental class did not make an effort to write down the equations used. The average pre-test problem-solving skills score percentage for IKPM-1 was moderate, while for IKPM-2, IKPM-3, and IKPM-4, it was still very low. The low average pre-test scores on these indicators were due to the fact that students in both the experimental and control classes had not yet received comprehensive material on optical instruments and were not familiar with the types of problem-solving questions at their school.

The average post-test problem-solving skills score percentage per indicator for IKPM-2 (planning strategies) was very high for the experimental class, while it was high for the control class. This was because students in the experimental class had a better understanding of the given problems, allowing them to plan strategies to solve them more accurately compared to the control class. For IKPM-1, IKPM-3, and IKPM-4, both the experimental and control classes were in the high category, but with a higher average percentage for each indicator in the experimental class. The higher problem-solving skills in the experimental class were attributed to the student-centered learning approach, where students were asked to find answers in groups to the problems presented in the given worksheets, allowing them to explore more deeply to solve these problems through practical activities using PhET Simulations.

The increase in the average post-test problem-solving skills score percentage per indicator aligns with research conducted by Astitin (2022), which stated that students responded very well to the application of the anchored instruction model assisted by PhET to enhance their understanding of concepts and problem-solving skills in physics. This is because anchored instruction can develop a deep understanding among students and improve their collaborative, cooperative, and negotiation skills through PhET simulations, which help them grasp abstract physics concepts. Similarly, Hafizah et al. (2014) concluded that there is a positive impact of the anchored instruction model on students' physics problem-solving skills, as students become problem solvers themselves in anchored instruction learning.

The improvement in problem-solving skills in both the experimental and control classes was further analyzed using the N-gain test. The IKPM scores of the experimental class showed a higher N-gain increase compared to the control class. This was because students in the experimental class could accurately identify the sufficiency of data in the problems given, plan appropriate and correct equations, apply these equations sequentially, and verify the correctness of their answers. In the anchored instruction model assisted by PhET, students were initially presented with complex problems related to the material being studied, which were then discussed and solved in groups through practical activities using PhET media. This allowed students to independently find answers to the problems through group work and class discussions based on their diverse answers.

The higher N-gain scores in the experimental class compared to the control class in this study are consistent with research conducted by Indriani et al. (2019), which found that the use of the anchored instruction model in the experimental class led students to more frequently meet problem-solving indicators compared to students in the control class who used conventional models. This was due to the experimental class students being accustomed to finding problem solutions based on their own experiences. Similarly, Rusdiana (2019) concluded that there was an improvement in students' physics problem-solving skills using PhET media because it fostered students' activeness and skills in addressing each given material. Amador-Bedolla & Olvera (2009) and Hulyadi, Muhali, & Fibonacci (2023) noted that understanding abstract scientific concepts often poses a challenge for students. Moore et al. (2014) reported that aids like interactive simulation media (e.g., PhET) and computational chemistry play a crucial role in facilitating students' comprehension of these concepts. These media bridge the gap between theory and practice, providing clear visualizations and allowing deeper interaction with the subject matter (Saudelli et al., 2021). Many scientific concepts, such as atomic structure, chemical bonds, and reactions, are difficult to grasp due to their intangible nature. Aids like PhET make these concepts more concrete and easier to understand (Oktaviana et al., 2020). PhET, being an interactive medium, allows students to directly engage with the concepts being learned. They can perform virtual experiments, alter variables, and observe real-time results, enhancing their understanding (Susilawati et al., 2022). The use of modern technology in education can increase students' interest and motivation. Students are more engaged in interactive, technology-based learning compared to traditional methods.

Research shows that students using PhET simulations have a better understanding of physics and chemistry concepts compared to those learning through traditional methods. These students also exhibit increased motivation and engagement in their learning (Susilawati et al., 2022). Another study indicated that the use of computational chemistry in teaching chemistry improves students' understanding of molecular structures and chemical reactions. Students can directly see how theory is applied in practice, enhancing their comprehension of chemical concepts (Echeverri-Jimenez & Oliver-Hoyo, 2021). Aids like PhET and computational chemistry are essential in science education, particularly in helping students understand abstract concepts. With visualization, interactivity, and the ability to conduct virtual experiments, these tools make science learning more engaging and effective. Proper implementation in the curriculum and project-based learning can maximize the benefits of these aids, ensuring that students gain deep understanding and practical application of scientific concepts.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that there is an influence of the anchored instruction model assisted by PhET on the physics problem solving abilities of students at SMAN 1 Sukamulia.

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