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The Influence of Problem-Based Learning Models and Attitudes in Physics on Students' Physics Problem-Solving Abilities

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Abstract: One of the student's abilities that needs to be improved in learning is problem-solving ability. However, in reality, students' problem-solving abilities are still relatively low, especially in physics subjects. This study aims to analyze the effect of learning models and attitude in physics on the problem solving. This research is a true experiment with a 2x2 factorial design. The population is all class X SMA Negeri 7 Luwu Utara years 2022/2023. The sample of two classes using simple random sampling techniques. Methods of data collection using attitude questionnaire on physics and physics problem-solving skill tests. Data analysis using two-way ANOVA The results showed that: There were differences in the physics problem-solving skills of students who were taught using problem-based learning models and those who were taught using discovery learning models, for attitudes to high physics, there were differences in problem-solving skills physics taught using problem-based learning models with those taught using discovery learning models, for low physics attitudes, there are differences in the physics problem-solving skills of students who are taught using problem-based learning models with those taught using discovery learning models, and there is no interaction between the learning model and attitudes toward physics on students' physics problem-solving skills.

Keywords: Attitude in Physics; PBL; Problem solving skill

Introduction

Physics learning in schools aims to prepare students for the ever-evolving world. Ploj Virtič (2022), explains that physics is a part of science that develops reasoning and analysis skills including concepts, facts, principles, laws and theories, and underlies the development of modern technology. When students say that learning physics is not easy, not only understanding the concept of physics but students must also be able to solve physics problems that they consider difficult. This is in line with the opinion put forward by (Hidaayatullaah et al., 2020) that the goal of learning physics in the industrial era 4.0 in schools is to prepare individuals to have life skills as individuals and citizens who are able to think critically, analytically, logically, creatively, and are able to solve problems. Pratiwi et al. (2021), also stated that one of the abilities that students must have in the industrial era 4.0 is the ability to solve a problem. Dewi et al. (2023), stated that physics learning can be a means of improving students' problem-solving abilities in schools. In addition, affective abilities are also very necessary in learning as a support for other abilities. According to Todd (2023), attitude is a view or feeling accompanied by a tendency to act towards certain objects. A positive attitude is seen when students are enthusiastic during the learning process, students are active in asking and answering questions given by the teacher, especially during group discussions in class. Mashuri et al. (2021), showed in the results of their research that students' social abilities were in the low, medium, and high categories. Meanwhile, students' cognitive abilities were in the low and medium categories.

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This shows that students' problem-solving abilities that are collaborated with social abilities are still lacking, there are still many students who have difficulty in solving the problems given. In fact, when the researcher conducted observations from Monday, July 18, 2022 to Friday, July 22, 2022, the researcher conducted interviews with several students at SMA Negeri 7 Luwu Utara and obtained several conclusions, namely, students are less interested in physics lessons, which causes students' curiosity and interest in physics lessons to decrease, in the learning process students sometimes pay less attention to the explanation given by the teacher because they feel bored and difficult to understand, students tend to work together in doing the practice questions given, and students are less confident with the answers given because they are afraid that the answers given are wrong, but not all students show this attitude. There are several students who show a great curiosity about physics lessons, have determination and feel happy in the learning process. These characteristics are what the researcher then concluded that there are differences in attitudes towards physics possessed by students.

Attitude towards physics is one of the supporting factors for students' success when learning physics, where a positive attitude can improve students' ability to learn. According to Salma et al. (2020), it is stated that many factors influence students' ability to learn. One of the factors is the attitude shown by students during the learning process. Lack of a positive attitude in learning can cause problem-solving abilities to be less than optimal. For this reason, a positive attitude needs to be developed in learning. According to Sturm et al. (2021), attitude itself contains three components, namely: cognitive or perspective components, where this component is related to a person's perception of the attitude object, affective or emotional components, components related to feelings of pleasure or displeasure towards the attitude object, and conation or behavioral components, components related to the tendency to act towards the attitude object.

One of the student abilities that needs to be improved in learning is problem-solving abilities. However, in reality, students' problem-solving abilities are still relatively low, especially in physics subjects. According to Veríssimo et al. (2024), problem-solving ability is an ability possessed by students in determining solutions by involving the acquisition and organization of information that has been obtained. Suwandi et al. (2021), stated that problem-solving ability is a basic ability of students in using reasoning and high-level thinking to find the right solution to the problems raised in the learning material. The weak ability of students to solve problems contained in learning indicates the difficulties experienced by students. The researcher also interviewed one of the physics teachers of class X at SMA Negeri 7 Luwu Utara, Baebunta Selatan District, North Luwu Regency, the teacher said that students' problem-solving abilities were not optimal, several conditions in the field during the learning process, namely, students had difficulty in working on physics problems if the questions given were different from the examples, students were less able to understand the problems contained in physics problems, students were less able to conclude the answers that had been given. This is in line with research conducted by Permatasari et al. (2020), that students in solving the physics problems given still have some students who have difficulty in identifying the problems contained in the questions, cannot state the elements that are known and asked.

Facing the challenges of the 21st century, teachers must be able to prepare students to become investigators, able to solve problems, think critically, and creatively. In the 21st century, when science and technology continue to advance and influence life, physics also plays an important role in education. As a consequence of this development, educators must be able to create a learning environment that encourages the acquisition of scientific and technical skills in students. Efforts to overcome students' physics problem-solving abilities require demands to apply a learning model that actively involves students. According to Gunawan et al. (2020), in the learning process it is important for students to use problems as a starting point in the learning process. Anbiya et al. (2023), stated that PBL encourages students to learn through exploration of real-world problems that are relevant to everyday life. Asrizal et al. (2023) stated that the use of PBL-based teaching materials has a significant influence on students' problem-solving abilities.

Wahyudi et al. (2022), stated that PBL is an innovative learning used to train problem-solving abilities through real experiences. Based on the results of observations carried out by observing the learning process in the classroom, the learning process in the classroom has not used a learning model that makes students directly involved in gaining real experience so that the material obtained is only from the views of others, when teaching physics the teacher uses learning steps, namely: the teacher conveys the learning objectives, the teacher prepares students to receive the material to be taught, the teacher divides students into several groups, and the teacher provides an explanation of the material as an introduction to the subsequent provision of problems to be solved by students, students are asked to enrich their knowledge to solve the problems given by reading various references. The learning steps used by physics subject teachers tend to

be with the discovery learning model where in this study the discovery learning model is referred to as a conventional learning model. Based on the description above, the following things are needed in class X of SMA Negeri 7 Luwu Utara, a learning model is needed that involves students to learn actively and get used to solving the problems presented and compare the physics problem-solving abilities of students who have high attitudes towards physics with students who have low attitudes towards physics.

Based on these two things, the researcher conducted a study on the learning model and found one learning model that can overcome this, namely the problem-based learning model. The problem-based learning model is a learning model that emphasizes the presentation of problems as a starting point so that it stimulates students' curiosity and will motivate them to be optimally involved. Problem-based learning is a learning activity that involves students' ability to search for and investigate something systematically, critically, logically, analytically so that they can formulate it themselves with confidence. Of course, this will eliminate the passive attitude of students in learning. PBL is one of the learning models that is widely used by teachers to train students' analytical skills towards problems in their environment. That implementing a problem-based learning model in class can change students' passive attitudes in learning to active ones.

Suboptimal problem-solving abilities need to be studied further to find out how students' physics problem-solving abilities are by paying attention to students' attitudes. In order for the description of students' physics problem-solving abilities to be better understood, students are directed by using problem-solving ability indicators and to measure students' problem-solving abilities using test methods, in addition to finding out students' attitudes using non-test methods by paying attention to attitude indicators. Based on this description, researchers have conducted research on the use of problem-based learning models and attitudes in physics on students' problem-solving abilities with the title "The Effect of Problem-Based Learning Models and Attitudes in Physics on the Problem-Solving Abilities of Class X Students of SMAN 7 Luwu Utara" The purpose of this study was to analyze the influence of learning models and attitudes in physics on the problem-solving abilities of class X students of SMAN 7 Luwu Utara.

Problem Solving Ability

Ability is the ability of each individual to do a job or master something that they want to do. Problems are the gap between expectations and reality, problems are not only faced by adults but school-age children also often face problems in their learning environment. The existence of these problems indirectly makes solving a basic human activity in their daily lives. Problem solving is an action that is considered a solution in solving problems. In the 21st century, students are required to have three abilities, namely, creative and innovative, critical thinking, problem-solving skills, and decision-making, learning with metacognitive abilities.

The steps for solving physics problems using I SEE. The steps for solving I SEE problems are: identifying relevant concepts, in this step students use the conditions stated in the problem to determine relevant physics concepts and identify the variables being sought. The next step is to Set up the problem, in this step students determine the appropriate equation to solve the problem. Next, Execute the solution, in this step students use equations, substitute known values into the equation to find the solution, and Evaluation, in this step students check the units and draw conclusions from the problem solving that has been made. Four steps in solving problems, namely: first understanding the problem, students write down all the elements or data given in the problem and the data asked in the problem. Second making a plan, students determine the equation that will be used to solve the problem contained in the problem. Third implementing the plan, students solve the problem contained in the problem according to the plan. And finally re-checking, students re-check the solution to the problem and provide information in the form of conclusions (Mukhlis et al., 2024).

Problem-solving skills include several steps consisting of understanding the problem by formulating the problem given, designing a solution to the problem by compiling work steps to solve the problem, testing the solution to the problem by substituting it into the predetermined work steps, and evaluating the solution to the problem, namely drawing conclusions. Based on the description above, it can be concluded that the ability to solve physics problems is a process or procedure to solve a problem related to the concept of physics. Problem solving ability is one of the competencies that must be possessed by students to achieve good learning competencies, where in learning students will continue to be faced with a problem related to the material that will be given. In this study, students' physics problem solving abilities were measured using indicators of understanding the problem, making plans, implementing plans and making conclusions (Evendi et al., 2024).

Attitudes towards Physics

Astalini et al. (2018), attitudes towards physics are the first thing seen from students whether they like physics lessons or not. A positive attitude towards physics will make students behave well and complete

their lessons well, conversely if students have a negative attitude towards physics, they will tend to stay away from, hate, and avoid physics lessons. According to Sandra et al. (2021), students who have a low or negative attitude towards physics will have a big impact on the physics learning process where this impact will affect the potential of students. The lack of positive attitudes towards physics lessons will affect the level of student performance in solving problems in physics.

That attitudes are also related to emotional management in learning and directing human behavior. Attitudes function to fulfill psychological needs in understanding anything in their environment, both positive and negative, identifying people who are liked or disliked, and defending themselves from internal conflicts. Negative attitudes towards a subject can worsen students' performance and abilities and reduce their self-confidence to learn it. Furthermore, attitude towards physics is the tendency or readiness of students to respond in facing and treating physics lessons consisting of beliefs (cognition), feelings (affection), and tendencies to act (conation). Based on the description above, it can be concluded that attitude towards physics is something related to student behavior which is very important to increase the potential in solving a problem in physics lessons. Attitude towards physics in this study was measured using the components of attitude towards physics, namely, cognition, affection, and conation.

Method

This type of research is a true experiment, with a 2x2 factorial design. The research design can be seen in Table 1. This research was conducted at SMA Negeri 7 Luwu Utara in the even semester of the 2022/2023 academic year. The population in this study was all class X students of SMA Negeri 7 Luwu Utara. The sample determination used the simple random sampling technique so that two classes were obtained, namely class X1 as the experimental class and class X2 as the control class. The learning process in class X1 uses a problem-based learning model and in class X2 uses a discovery learning model. The data collection technique in this study was by using an attitude questionnaire sheet on physics and physics problem-solving ability test questions.

Table 1. Research Design

Attitude towards Physics (B)		Learning Model (A)
Attitude towards Physics (B)	PBL (A1)	Discovery (A2)
High (B1)	Y [A1B1]	Y [A2B1]
Low (B2)	Y [A1B2]	Y [A2B2]

Description:
Y [A1B1]: Problem solving ability of students from classes with PBL model and Attitude towards physics is high.
Y [A1B2]: Problem solving ability of students from classes with PBL model and attitude towards physics is low.
Y [A2B1]: Problem solving ability of students from classes with discovery model and Attitude towards physics is high.
Y [A2B2]: Problem solving ability of students from classes with discovery model and attitude towards physics is low.

The data in this study were obtained from the attitude questionnaire sheet in physics consisting of statements with 4 (four) answer choices, namely, for positive statements 4 (strongly agree), 3 (agree), 2 (less agree), and 1 (disagree) while for negative statements 4 (disagree), 3 (less agree), 2 (agree), and 1 (strongly agree). And problem-solving ability test questions with a score of 0 to 16. The data source in this study is a primary data source obtained directly from the first source (without intermediaries) both individuals and groups, namely students of class X SMAN 7 Luwu Utara. Data analysis in this study consisted of basic statistical analysis and two-way ANOVA. All analyses of this study used a significance level of 5%. Before the physics problem-solving ability test instrument was given to the sample class, it was first tested to determine the validity, reliability, difficulty and discriminatory power of 9 questions. For the attitude questionnaire instrument in physics, it was tested to determine the validity and reliability of 46 statement items. Based on the results of the trial, 5 physics problem-solving ability test questions were obtained that met the requirements and 32 attitude questionnaire statements in physics used in the study.

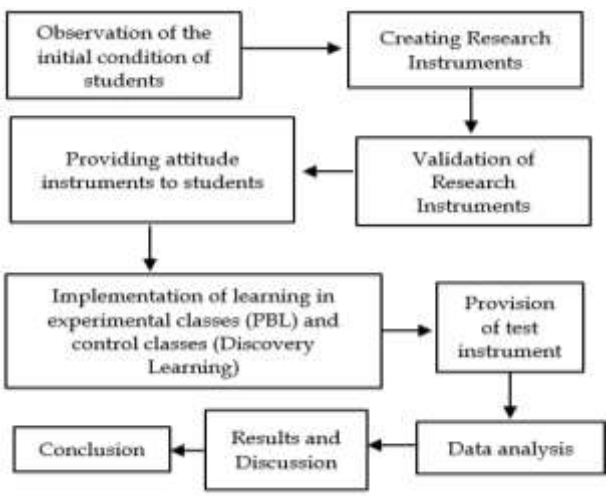

Figure 1. Research flow

Result and Discussion

Research Results

The description of students' physics problem-solving ability scores was obtained by conducting a descriptive analysis of the scores obtained through the physics problem-solving ability test. Table 2 shows that the average score of the class taught using the problem-based learning model is higher than the class taught using the discovery learning model. Likewise, the highest and lowest scores show that the experimental class is higher than the control class.

Table 2. Statistics of Students' Physics Problem-Solving Ability Scores

Description	Learning model	
	Problem Based	Discovery
Sample Size	30.00	30.00
Highest Score	55.00	44.00
Lowest Score	19.00	11.00
Mean	38.23	31.65
Standard Deviation	9.24	6.92

Table 3 shows that students who are in the high physics attitude category and are taught using the problem-based learning model have a higher average score than those taught using the discovery learning model. Likewise, students who are in the low physics attitude category and are taught using the problem-based learning model have a higher average score than those taught using the discovery learning model.

Table 3. Two-way ANOVA Test Results

		Learning model
Attitude towards Physics	Problem Based (A1)	Discovery (A2)
Attitude towards Higher Physics (B1)	n = 15	n = 15
	$\sum(x) = 672$	$\sum(x) = 501$
	$\sum(x)^2 = 30736$	$\sum(x)^2 = 17123$
	$\bar{x} = 44.80$	$\bar{x} = 33.40$
	S = 6.71	S = 5.28
	$s^2 = 45.02$	$s^2 = 27.83$
Attitude towards Physics Low (B2)	n = 15	n = 15
	$\sum(x) = 485$	$\sum(x) = 460$
	$\sum(x)^2 = 16339$	$\sum(x)^2 = 14956$
	$\bar{x} = 32.33$	$\bar{x} = 30.67$
	S = 6.85	S = 7.79
	$s^2 = 46.95$	$s^2 = 60.67$
∑	n = 30	n = 30
	$\sum(x) = 1157$	$\sum(x) = 961$
	$\sum(x)^2 = 47075$	$\sum(x)^2 = 32089$
	$\bar{x} = 77.31$	$\bar{x} = 64.07$
	S = 13.56	S = 13.07
	$s^2 = 91.97$	$s^2 = 88.50$

Table 4. Summary of ANOVA Test Results

					F_t	
Source of Variance	JK	Db	RJK (s^2)	F_h	0,05	Test Decision
Between Groups	76627.33	3	25542.44	395.059	4.1	H0 rejected
Between A	640.27	1	640.27	9.90	4.1	H0 rejected
Between B	2331.27	1	2331.27	36.06	4.1	H0 rejected
AxB Interaction	216.60	1	216.60	3.35	4.1	H0 accepted
Within Groups	2526.67	56	64.65			
Total	4388	62				

Grouping Based on the Learning Used is Learning Based on Problem-Based Learning and Discovery Learning Models

Based on Table 4 shows Fcount = 395.06 and Ftable = 4.10 (Fcount ≥ Ftable) so that H1 is accepted. This means that there is a difference in the physics problem-solving ability of students who are taught using problem-based learning models with those taught using discovery learning models in class X students of SMA Negeri 7 Luwu Utara.

Grouping Based on Attitudes towards High Physics

Table 4 above based on attitudes towards physics, shows Fcount = 9.90 and Ftable = 4.10 (Fcount ≤ Ftable) so that H0 is rejected. This answers the second hypothesis for attitudes towards high physics, there is a difference between the physics problem-solving ability of students who are taught using problem-based learning models with students who are taught using discovery learning models in class X students of SMA Negeri 7 Luwu Utara.

Grouping Based on Low Physics Attitudes

The inter-row analysis of the low physics attitude group obtained Fcount = 36.06 and Ftable = 4.20 (Fcount ≥ Ftable) so that H0 is rejected which indirectly answers the third hypothesis, namely for low physics attitudes, there is a difference between the physics problem-solving abilities of students taught using problem-based learning models and those taught using discovery learning models in class X students of SMA Negeri 7 Luwu Utara.

Interaction between Learning Models and Attitudes in Physics

The interaction effect of learning variance sources and attitudes in physics produces Fcount = 3.35 and

Ftable = 4.10 (Fcount ≤ Ftable). H0 is accepted, meaning there is no interaction between the learning model and attitudes in physics on the physics problem-solving abilities of class X students of SMA Negeri 7 Luwu Utara.

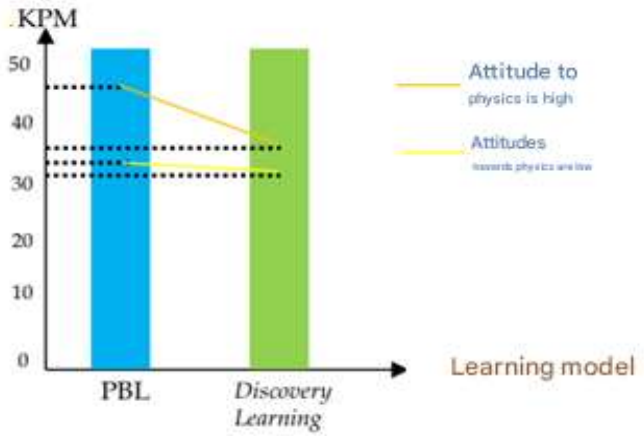

Figure 2. Interaction patterns between learning models and attitudes in physics

Discussion

Overall, the physics problem-solving ability of students taught using the problem-based learning model is higher than that of students taught using the discovery learning model. The use of problem-based learning models and discovery learning models can provide a good role in students' physics problem-solving abilities. Between the two learning models, students taught using the problem-based learning model have a good physics problem-solving ability score compared to those taught using the discovery learning model. This is because students taught using the discovery learning model are more passive than students taught using the problem-based learning model. This can be seen in the learning process, during the problem orientation, students in the class taught using the problem-based learning model are very enthusiastic in responding to the feedback given by the teacher, while the class taught using the discovery model does not look enthusiastic, only some respond to the feedback given by the teacher.

When conducting experiments for classes taught with problem-based learning models, they appear compact in doing this, in doing experiments, students share with each other, one does the experiment and the other helps the other part by filling in the student worksheets and looking for other learning resources to fill in the student worksheets. Meanwhile, in classes taught with the discovery learning model, in conducting experiments, only some students participate in working on them and others just watch without contributing. This is similar to Dutch's statement (Yew & Goh, 2016), which states that PBL is an instructional method that challenges students to learn to learn, work together in groups to find solutions to problems they encounter. According to Hastuti in Rahmana et al. (2021), the problem-based learning model is a learning model that presents problems based on real life to be solved by students, so that it attracts students' interest in solving them. The problem-based learning model is a learning model that provides students with a real problem and students will try to explore and solve the problem. Problem-based learning models can optimize students' problem-solving abilities either individually or in a group. Problem-based learning models accustom students to solving a problem that is seen through the process of thinking individually or in groups (Dewi et al., 2023).

The discovery learning model is an active learning model by finding, investigating so that it can be remembered by students. Through the discovery model, students learn to think analytically and try to solve a problem themselves. The discovery model is a way for students to express ideas through discovery. The discovery model emphasizes students to understand a concept from the material being studied actively and independently, which then students will conclude the material. In this case, problem-based learning can provide a more meaningful learning process and have a better impact on improving students' problem-solving abilities more optimally compared to the discovery learning model. This is in line with research by Hasanah et al. (2023), stating that the PBL learning model can affect students' physics problem-solving abilities by 88%. The hypothesis test were obtained at a significant level, which means that there is a significant influence the problem-based learning model and students' problem-solving abilities. In a study by Siregar et al. (2022), it was stated that the results of the meta-analysis conducted showed that there was an influence of learning with the problem-based learning model on improving students' physics problem-solving abilities. The problem-based learning model was better at improving students' physics problem-solving abilities. The results of their study it was shown that there was a significant difference in the results of the pretest and posttest of students, namely in the pretest the average student score was 46 and in the posttest it was 82, so this shows that interactive learning media based on problem-based learning can improve students' problem-solving abilities.

For students who have a high attitude towards physics, there is a difference in the ability to solve physics problems between students who are taught using a problem-based learning model and students who are taught using a discovery learning model. The

difference in attitudes towards physics between students who are taught using a problem-based learning model and a discovery learning model can also be seen from the fact that students who have a high attitude towards physics understand more, are more confident, feel happy in discussing or solving, and are more enthusiastic when the teacher gives feedback in the physics learning process. The application of a problem-based learning model also accustoms students to always solve a given problem and also accustoms students to always be active in discussions so that it can create an attitude towards physics in students towards physics lessons. Students who have a high attitude towards physics tend to have a desire to always be active and stand out in learning, thus encouraging them to obtain more optimal learning outcomes, in teaching and learning activities students with a high attitude towards physics create more enjoyable and interesting learning activities.

This is in line with Helmi et al. (2023), the Effect of Problem Based Learning on Changes in Problem Solving Abilities and Attitudes of High School Students in Physics Subjects shows that there is an increase in problem solving abilities using problem based learning and a positive influence of students' attitudes towards physics in learning with the problem based learning model. This can be seen from the average score of the physics problem solving ability of students who have a high attitude towards physics in class X1 taught using the problem-based learning model obtained 44.80, in class X2 students who are taught using the discovery learning model obtained 33.40. Students who are taught using the problem-based learning model have higher problem solving abilities when compared to students who are taught using the discovery learning model. This means that if students have a high attitude towards physics in learning, it will be in line with the physics problem solving ability test, namely good (high). Conversely, if students have a low attitude towards physics, it will also affect the physics problem solving ability test, namely low.

Relationship between student attitudes and learning outcomes, where the higher the student's attitude, the higher the learning outcomes and if the student's attitude is low, the learning outcomes will also be low. A fairly close influence between student attitudes and physics learning outcomes, which means that students who have good attitudes will also have good learning outcomes. Students with a high physics attitude during the learning process are very enthusiastic about asking questions if there is material that is not understood, which shows that students' curiosity about physics lessons is quite high. And also during learning, students who have a high attitude towards physics are seen to try harder to do the tasks given compared to students who have a low attitude towards physics. This is in line with research conducted by Sagatbek et al. (2024), stating that students who have a high attitude will spend more time studying physics, finding solutions to physics problems and increasing their knowledge of physics. Conversely, students who have a low attitude will consider physics as a difficult subject, have less interest in learning and will affect their learning outcomes (Zakirman et al., 2023; Sheldrake et al., 2019).

Research conducted by Handayani et al. (2021) and Capriconia et al. (2022), states that attitude is the first thing seen from students if they like physics lessons or not. A positive attitude makes students behave well and complete their academics well, conversely if students have a negative attitude, they will tend to stay away from, hate and avoid physics lessons. For students who have low attitudes towards physics, there is a difference in the ability to solve physics problems between students who are taught using problem-based learning models and students who are taught using discovery learning models. Most students who have low attitudes towards physics do not like physics lessons so that when studying, students pay less attention to the teacher's explanation or even do not listen to the teacher's explanation. There are even some students who do not know the basic knowledge of physics subjects. If the basics of physics lessons are not known, it will be difficult to understand to continue to the next material, so there is definitely no time to study (Nurmasyitah et al., 2022).

Other difficulties experienced by students in class such as there are still students who are always behind in doing physics assignments with the specified time. This is in line with the research of Tullis et al. (2020), Analysis of Student Attitudes Towards Physics Subjects at SMA Ferdy Ferry Putra, Jambi City, which states that students' attitudes towards physics lessons dominate the sufficient category, this is because many students consider physics difficult, resulting in students' ability to learn also decreasing. Research conducted by Rizkita et al. (2022) states that there are still many students who do not understand physics lessons because students' attitudes tend to be negative towards physics lessons, such as not liking physics lessons, not being interested in adding time to study physics and considering physics to be difficult. Research conducted by Suwonjandee et al. (2018), found that both teachers and students in Thailand in solving physics problems did not try to understand the problems contained in the questions and only tried to find what formula was used to solve the problem. This causes students' negative attitudes to increase, so that when given problems with a new

model, students tend to have difficulty. The problem-solving ability of physics taught using a problem-based learning model with low physics attitudes obtained an average score of 32.33.

In classes taught using the discovery learning model, an average score of 30.67 was obtained, so it can be concluded that students in class X1 have a higher average problem-solving ability score than students in class X2. There is no interaction between learning models and attitudes in physics on students' physics problem-solving abilities. This study was conducted to determine the influence of problem-based learning models and discovery learning models seen from the differences in students' attitudes in physics on students' physics problem-solving abilities in class X of SMA Negeri 7 Luwu Utara. From this study, it is known that learning by implementing problem-based learning models provides a new influence for students to further improve their physics problem-solving processes and abilities. Because learning by implementing problem-based learning models provides opportunities for students to decide what experiences they focus on, what abilities they want to develop, and how to find concepts from the experiences they want to experience by thinking independently constructing ideas that exist in themselves through active and enjoyable learning.

This is in line with research conducted by (Hidaayatullaah et al., 2020), the results of the study showed that the application of the PBL model can increase students' learning activities and physics problem-solving abilities. Students are required to develop their abilities in learning so that they can form their own knowledge and find meaning from something that has been learned indirectly, they can remember what they have learned longer. Learning by implementing a problem-based learning model can make teaching and learning activities valuable, fun and active. Through the problem-based learning model, students can find concepts and then put forward ideas that they already have and test and discuss these ideas openly. This can certainly help students to build their abilities, one of which is the ability to solve physics problems. This is in line with Smith et al. (2022), which states that the problem-based learning model does not expect students to just listen, take notes, then memorize the lesson material, but through PBL students actively think, communicate, search for and process data, and finally conclude. Furthermore, Purnama et al. (2021), stated that the problem-based learning model is a learning model that presents real-life problems as the center of learning so that students can learn to solve these problems.

Based on the research conducted and the results of statistical tests (Casula et al., 2021; Quick & Inwinkl, 2020), it shows that the three hypotheses are proven, while the fourth hypothesis is not proven and states that there is no interaction effect between the learning model and attitudes in physics on the physics problem-solving ability of class X students of SMA Negeri 7 Luwu Utara. We can see in Figure 1 that the lines do not intersect. This means that there is no interaction between the two even though the average score of the physics problem-solving ability test for class X1 is higher than class X2. The absence of interaction between the learning model and attitudes in physics on the physics problem-solving ability of students is thought to be caused by the strength of each variable's influence. The findings in this study conclude that there is a strong main influence of the independent variables and moderator variables on the dependent variable. In addition, there are other factors that emerge in the study that affect students' physics problem-solving ability that are not directly measured in this study. These factors include student activity, student self-confidence, student learning motivation, and the ability to work together in groups.

Student activity plays an important role in determining how effectively they can absorb material and apply it in problem solving. Self-confidence also contributes significantly, because confident students are more likely to face challenges with a positive attitude and try to find solutions. Motivation to learn is the main driver for students to continue trying to understand complex physics concepts (Silverman, 2015). Finally, the ability to work together in groups allows students to exchange ideas and strategies in solving problems, thereby increasing the effectiveness of problem solving as a whole. Overall, these factors show the importance of a holistic approach in education that focuses not only on academic aspects, but also on psychological and social aspects in developing students' problem-solving abilities. The problem-based learning model is very influential in achieving students' physics problem-solving abilities, because in the model students are required to work together with group friends by sharing tasks in working on group assignments. The activeness of students in the learning process is very helpful and encourages to create a fun and interesting learning atmosphere. This learning model can also support students' curiosity with the knowledge they learn.

Conclusion

Based on the analyzed research data, it can be concluded that there is an influence of learning models and attitudes in physics on the problem-solving abilities of class X students of SMAN 7 Luwu Utara. Based on the results and conclusions in this study, the researcher has several suggestions for further researchers who want to

apply problem-based learning models to prepare and present problems in the form of animations or videos related to everyday life so that students are more interested in the learning process.

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The authors declare no conflict of interest.

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