



The Influence of Problem Based Learning and Self Directed Learning Models on Students' Problem Solving Abilities

Lisa Sutami Suharlan^{1*}, Muhammad Arsyad¹, Pariabti Palloan¹

¹Physics Education, Postgraduate Program, Universitas Negeri Makassar, Makassar, Indonesia.

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Corresponding Author:

Lisa Sutami Suharlan

utamisuharlan@gmail.com

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Abstract: This research is actual experimental research using a 2x2 factorial design. The aim of this research is to analyze the overall difference in the Problem Solving abilities of students who are taught using the Problem Based learning model and those taught using the discovery learning model and to analyze the interaction between the learning model and self direct learning on the solving abilities of class XI MIA students. The sample in this study was 48 students consisting of two classes XI MIA 1 as a class taught using the Problem based learning model and class XI MIA 3 as a class taught using the discovery learning model. The average score for problem solving abilities taught using the Problem based learning model was 67.50 and those taught using the discovery learning model was 57.90. The difference in the average score of Problem Solving abilities of students who are taught using the Problem Based learning model and those taught using the discovery learning model for students who have high self-directed learning is 67.30 and 60.20. Meanwhile, the average score for problem solving abilities for self-directed learning students is low at 62.70 and 56.30. The ANOVA test results show that there is no interaction between the learning model and self-directed learning on students' Problem Solving abilities.

Keywords: Problem based learning model; Problem solving ability; Self directed learning

Introduction

The very rapid development of science and technology currently forces educational people to change the way they think, act, habits, appearance, success, values and beliefs, interactions and communication. The implementation of learning must be able to form a whole person to form a person who learns throughout life (Supriadi et al., 2020). Most of the learning carried out in schools means that if students cannot master 21st century skills optimally, this will have an impact on their output (Redhana, 2019). According to Zubaidah, the way to renew the quality of achieving 21st century skills is to change the situation during the learning process (Ariyansyah, 2018). Based on observations related to students' physics test results, there were still students who, according to educators, found several characteristics in solving the questions, namely: students were unable to complete all the questions given, students often had difficulty translating the questions and students were used to sample

questions taught so that if a question changes a little they tend not to answer the question until it is finished. Markus et al. (2018) states that achieving 21st century skills can be done by renewing the quality of learning, helping students increase and develop participation, encouraging cooperation and communication and cultivating creative thinking skills so that learning can be centered on student activities with guidance and supervision. from the teacher. According to Sanjaya, the problem faced in learning is the weakness of the learning process, where children are not encouraged to develop thinking skills.

In general, Physics learning aims to improve mastery of concepts and Problem Solving abilities (Docktor, 2015). This goal can be said to be achieved if students are able to apply the concepts they have in different contexts and are able to solve existing problems. Students don't just retain knowledge and use formulas to solve problems. There is a need to change the learning atmosphere in an interesting way, one of which is by trying to change the learning model that can

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develop high-level thinking skills and solve problems. According to Davis and Alexander, problem solving ability is a complex process involving several basic psychological activities (Hardianty, 2011). Problem solving ability is a skill in the 21st century that students must prepare for the future. In the 21st century, learning physics provides a person with the ability to be able to improve problem solving abilities (Baran, 2016). Indicators of Problem Solving abilities according to Doctor-Heller are visualization, physics approach, special application of physics concepts, mathematical procedures and drawing logical conclusions (Hidayat et al., 2017).

Problem solving ability is also defined as an individual's ability to use knowledge and logical thinking to analyze information from a problem and find a solution. Setianingrum (2016) obtained research results that the majority of students had low problemsolving abilities, students were used to questions that required simple concepts and had difficulty if they were given more complex questions. A learning model that can improve students' problem solving abilities is problem based learning (Nisak et al., 2017). The problem based learning model is a learning model that confronts students with a problem so that they develop higher thinking abilities and gain new knowledge related to the problem (Lestari et al., 2015). Nurmahasih et al. (2023) found that there was progress in student learning outcomes after practicing the PBL model in physics learning, increasing learning independence, creative thinking skills, critical thinking skills, argumentation skills, science process skills and problem solving abilities.

This learning model trains students to be more active in conveying, asking questions and understanding the material being taught so as to create a pleasant learning environment for students. A pleasant environmental situation will create motivation in students so that it can influence students' ability to solve problems (Musliha et al., 2021). In line with previous research conducted by Oktaviana et al. (2020), it was stated that a significantly better increase in problem solving abilities was obtained when learning used the problem based learning model. Self-directed learning is defined by Knowles (1975) as a process where a person has the initiative, with or without the help of others, to analyze their own learning needs, identify learning resources, select and implement appropriate learning strategies and evaluate their own learning results. Indicators of self-directed learning are awareness, planning in learning, discipline in learning, self-confidence, hard work, originality (Permatasari, 2021). There are 5 syntanks for the problem based learning model, namely student orientation, organizing students

to learn, guiding individual experiences or group, develop and present work results and evaluations (Yulianti, 2019). The aim of the problem based learning model according to Barrows & Tamblyn is to improve students' application of knowledge, in addition to problem solving abilities, also critical thinking abilities and self-directed learning abilities.

Jarvis stated that self-directed learning possessed by students is defined as the ability to take the initiative in regulating, managing and controlling the learning process to overcome various problems in learning by using various alternative or learning strategies (Azizah, 2012). Individuals must know the resources they have, task requirements, time to use strategies, how to solve problems under difficulty, self-regulation, and monitor personal working conditions when involved in a task so that they can complete the task effectively (Liu, 2016). The ability of self-directed learning (Irvani, 2019) was found to contribute to students' problem-solving abilities in light-reflecting material. High self-directed learning abilities make students willing to seek knowledge independently and determine what knowledge is needed in their learning activities. when involved in a task so that it can complete the task effectively (Liu, 2016). The use of students' metacognitive skills and strategies, such as task analysis, planning, monitoring, checking and 5 reflection, self and group monitoring skills, reading, writing skills, and self-directed learning helps them in problem solving (Tachie, 2019).

Mason et al. (2011) obtained results that surface feature students found it easy to group questions into business categories if the questions asked about business. This was also found in the schools studied by researchers that students experienced difficulties if the questions were changed to be different from the initial formula. This could happen when students only memorized the formula without reinforcing the concept or the explanation of the formula or equation was not accompanied by an explanation. Even though it is included in the category of thinking skills used by teachers to teach students to think, in practice solving problems is the main factor in learning physics (Ceberio et al., 2016). Students also tend not to check the validity of their answers. This is in accordance with Lin et al. (2013), students who have low abilities in solving physics problems tend to recognize problems based on the problem presentation (surface features), do not carry out evaluations, and tend to use formulas in solving problems.

Mason et al. (2011) also get the results that surface feature students are easy to group questions into categories business if you ask about business. If questions are based on effort but what is asked about

other things, for example speed, then students surface feature is having difficulty detecting understand the basic concept of the problem. Based on the description above, students' knowledge can be obtained with high self-directed learning abilities, so that the more knowledge, the easier it is to solve problems. Researchers will conduct research on the topic of the influence of problem based learning and self directed learning models on students' problem solving abilities.

Method

This research is a type of actual experimental research using a 2x2 factorial design. The research was conducted in two classes, the experimental class (MIA 1) which was taught using the problem based learning model and the control class (MIA 3) which was taught using the discovery learning model. The following is a 2x2 factorial design pattern.

Table 1. Factorial Research Design Patterns (Supardi, 2017)

		Learning model
Self Directed Learning	Problem Based Learning (A ₁)	Discovery Learning (A ₂)
Tall (B ₁)	Y (A ₁ B ₁)	Y (A ₂ B ₁)
Low (B ₂)	Y (A ₁ B ₂)	Y (A ₂ B ₂)
Amount	Y (A ₁ B ₁) +Y (A ₁ B ₂)	Y (A ₂ B ₁) +Y (A ₂ B ₂)

Information:

- Y :Problem solving ability
- A1 :Problem based learning model
- A2 :Discovery learning model
- B1 :High self-directed learning
- B2 :Low self-directed learning
- A1B1 :High self-directed learning taught using a problem based learning model
- A1B2 :Low self directed learning taught by problem based learning model
- A2B1 :High self-directed learning taught using the discovery learning model
- A2B2 :High self-directed learning taught using a problem based learning model.

The population in this study were all students in class XI MIA SMA Negeri 5 Central Maluku, class division is not based on performance which is divided into 3 classes, namely MIA 1, MIA 2 and MIA 3, pay attention to table 2.

Table 2. Distribution of Class XI Students

Class	Amount
XI MIA 1	24
XI MIA 2	25
XI MIA 3	24

Source: School Data (2023)

Based on Table 2, the samples in the study were classes XI MIA 1 and XI MIA 3 and there are 50% of the 24 students, meaning that there are 12 students in each category who have high self-directed learning and low self-directed learning. In class XI MIA 3 there are also 50% of the 23 students, meaning there are 12 students in each category who have high learning motivation and low learning motivation. This research procedure is divided into three stages, namely the preparation stage, implementation stage, and reporting stage.

The preparation stage is the beginning of starting an activity before researchers collect data in the field, prepare lesson plans, teaching materials, LKPD, questionnaires and problem solving ability test instruments. The second stage includes validity testing, then distributing questionnaires to students before applying the learning model in each class and then carrying out the learning process by applying the problem based learning model in class XI MIA 1 and the discovery learning model in XI MIA 3. The final stage of this research administering problem solving ability tests. The problem solving ability test was carried out in the control and experimental classes for 2 hours of learning. Validity and reliability tests are as follows:

Validity Test

Knowing the validity of the item, the data obtained is processed using the product moment correlation equation (Supardi, 2017), seen in equation 1.

$$r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\{N \sum X^2 - (\sum X)^2\} \{N \sum Y^2 - (\sum Y)^2\}}} \quad (1)$$

A significant level of 5% for the problem solving ability question instrument was found to be 7 questions declared valid, 4 questions declared invalid. In the self-directed learning questionnaire, 21 statements were declared valid, 15 questions were invalid.

Reliability Test

The instrument reliability coefficient calculated by the Cronbach's alpha formula can be seen in equation 2:

$$r_{ii} = \left(\frac{k}{k-1}\right) \left(1 - \frac{\sum s_i^2}{s_t^2}\right) \quad (2)$$

Based on the analysis, the reliability obtained for the problem solving ability test instrument, a Cronbach's alpha value of 0.61, was declared reliable and the self-directed learning questionnaire, a Cronbach's alpha value of 0.82, was declared reliable, fulfilling the requirements for use in research. After testing the validity and reliability, the instrument for problem solving ability that will be used to measure problem solving ability is 7 questions. The questionnaire that will

be used to measure self-directed learning consists of 21 statement items. In the final stage, the data is processed and hypothesis testing will be carried out, but first we carry out basic testing, namely the normality test to determine the normal distribution of the data and homogeneity to determine whether the variations are homogeneous as follows:

Normality Test

Hypothesis testing, first a basic test is carried out, namely the data normality test. Normality test, for this test the Liliofers formula is used which is seen in equation 3:

$$Z_i = \frac{x_i - \bar{x}}{s} \quad (3)$$

In class the calculated L0 value = 0.171 in class XI MIA 3 means that in the control class the data is normally distributed.

Homogeneity Test

Testing the equality of two variances is used to find out whether the data to be correlated meets the constant variance seen in equation 4:

$$F = \frac{\text{large variance}}{\text{smallest variance}} \quad (4)$$

Homogeneity testing was carried out using Microsoft Excel with Fcount = 0.93 and Ftable = 2.01 at a significance level of 0.05, so it can be concluded that the problem solving ability scores of class XI MIA students at SMAN 5 Central Maluku using problem based learning and discovery learning models are homogeneous.

Hypothesis Testing

In this study, to test the hypothesis using two-way analysis of variance at a significance level of $\alpha = 0.05$. Hypothesis testing is calculated using SPSS version 25 for Windows.

Result and Discussion

Descriptive analysis of problem solving abilities. The statistical test results of students' problem solving ability scores obtained after the treatment given to classes XI MIA 1 and XI MIA 3 are presented in table 3. The highest score and the lowest score also show that the experimental class using problem based learning is higher than the control class which uses the discovery learning model. The following are the results of the Anova test in Table 4.

Table 3. KPM Statistical Test Results

Description	Learning Model (A)	
	PBL (A1)	DL (A2)
Sample size	24	24
Theoretical highest score	98	98
Theoretical lowest score	0	0
Highest empirical score	87	86
Empirical lowest score	40	42
Average	67.50	57.90
Standard deviation	11.10	12.90

Table 4. Anova test

Sources of Variance	df	F _{count}	F _{table}	Sig
Model	1	6.74	4.06	0.01

Based on Table 4, it shows Fcount = 6.74 and Ftable = 4.06 (Fcount ≥ Ftable, then H0 is rejected) so H1 is accepted, so there are differences in the solving abilities of students who are taught using the problem based learning model and the discovery learning model in class XI MIA SMAN 5 Central Maluku. Analysis of the interaction between learning models and self-directed learning after testing can be seen in Table 5.

Table 5. Anava test

Sources of Variance	df	F _{count}	F _{table}	Sig
SDL * MODEL	1	1.31	4.06	0.26

Based on Table 5, it shows Fcount = 1.30 and Ftable = 4.06 (Fcount ≤ Ftable, then H0 is accepted, meaning there is no interaction between the learning model and self-directed learning on problem solving abilities. Look at Figure 1.



Figure 1. There is no interaction between learning models and self-directed learning

Based on Figure 1 above, it can be seen that the two lines do not intersect. The picture describes that there is no interaction between the learning model and self-

directed learning (for high and low self-directed learning students) on students' problem solving abilities. The average score for problem solving abilities taught using the problem based learning model with self directed learning is low at 65.60. The average score for problem solving abilities taught using discovery learning with self-directed learning is low at 56.30. This shows that students in the problem based learning model with low levels of self directed learning obtained a higher average score of problem solving ability compared to the average score of problem solving ability of students in the control class who were taught using discovery learning.

Learning uses a problem based learning model in application and also uses PhET assistance on wave material, this triggers students to be more enthusiastic about learning in groups, so that it can become a medium that can be used to improve students' problem solving abilities. Imaniah et al. (2023) stated that there is an influence of the PhET-assisted PBL model on wave material which has a contribution to students' abilities seen from the learning outcomes obtained by students. Testing the first hypothesis based on ANOVA analysis shows $F_{count} = 6.70$ and $F_{table} = 4.06$ ($F_{count} \geq F_{table}$, so H_0 is rejected) so H_1 is accepted. Overall, there is a difference in students' problem solving abilities between those taught using the problem based learning model compared to those taught using the discovery learning model in class XI MIA students at SMAN 5 Central Maluku.

There is a significant difference between students who take part in learning using the problem based learning model compared to students who take part in learning with the discovery learning model, this is because students who are taught using the problem based learning model are encouraged to be presented with authentic, real problems. in a systematic way so that it will train students to think to solve the problems presented. According to Ayse et al. (2011), the main principle of Problem Based Learning is to maximize learning by investigating, explaining, and solving contextual and meaningful problems. Therefore, this Problem Based Learning model can be used to encourage students to be active in the learning process. Dewi et al. (2023) also found that there was an influence of the PBL model on students' physics problem solving abilities in the very high category, so that the PBL model could be said to be able to be used to improve physics problem solving abilities. Research result Syam et al. (2020) shows that students trained with problem-based learning have a high level of scientific knowledge. Ausubel's theory explains that a contextual learning process that correlates learning material with daily life will be much more meaningful for students, thereby

equipping students with problem-solving abilities (Wahyuni et al., 2020). This is because problem solving is a thinking ability that requires a variety of rules so that it can develop students' abilities (Aka et al., 2010). Some researchers also believe that gender influences physics problem solving abilities because, further Febriani et al. (2021) if we look at the scores achieved by students, they find that those who get high problem solving ability scores are female students in both the experimental class and the control class.

Abraham also said that although men and women have comparable creative and divergent thinking behavior, differences in brain activity suggest the two may use different cognitive strategies when performing these tasks. These findings indicate that men and women have different characteristics in various aspects of creative thinking skills (Trianggono et al., 2018). The facts obtained when conducting research on students while working in groups are much more active in this case when the learning process is presented with the help of PhET simulation media, for female students are also active in the learning process. Susilawati et al. (2022) PhET media is one of the media that increases mastery of concepts in learning so that problem solving can be improved using PhET. The final finding obtained was that the highest scores were obtained by female students in both the experimental and control classes.

Abraham et al. (2014) stated that when using their creative minds, women use more areas in the brain that are involved in theory of mind and reference processes. Based on this opinion, it is possible that the reference process supports the creation of thoughts to create details from the details of the answers given. Based on this, it is in line with research conducted by Fitriani (2015) that women have higher money problem-solving abilities compared to women, because female students are more likely to have the desire to succeed in learning. According to Hodiyanto (2017), female students when taught using the problem based learning model have higher problem solving abilities. Learning with the problem based learning model provides a process of transferring knowledge to understand problems in everyday life, creating a relationship between the two directions of learning and the environment so that students who obtain information from the environment will use materials and materials to gain understanding and can be used as guidelines and learning objectives. According to Haryanto, learning physics in everyday life is needed to help improve students' ability to analyze objects around them. Fischer et al stated that by creating physics problems that are contextual and embedded in students' lives, it is hoped that solving physics problems will be meaningful and interesting for students (Sari et al., 2023).

This is in line with the opinion of Hosnam (2014) with the main aim of problem based learning, not delivery. Most of the knowledge given to students is focused on developing thinking skills and efforts so that students are able to solve problems by having high problem-solving abilities. The PBL model for physics problem solving abilities in temperature material has an effective influence on physics problem solving abilities (Dewi et al., 2023). Evendi et al. (2021) also found that the application of the problem based learning model showed improvement and encouraged students to actively participate. Students who had high self-directed learning in the experimental class were 69.40. The self-directed learning possessed by students in the control class also influences students' solving abilities, this can be seen from the average score of the problem-solving ability of students who have high self-directed learning in the control class, which is 64.50. Based on the research results above, it strengthens the assumption that self-directed learning can influence the variable being measured (problem solving ability).

This is in line with research conducted by Irvani (2019) which found that self-directed learning abilities contributed to students' problem-solving abilities in light-reflecting material. High self-directed learning abilities make students willing to seek knowledge independently and determine what knowledge is needed in their learning activities. The average score results in classes taught using the problem based learning model for students who have low self-directed learning is 65.60. The average score in classes taught using the discovery learning model for students who have a low self-directed learning average score is 56.30. Based on this, the average score for self-directed learning between the experimental class and the control class was that the problem-solving ability score was higher for students who had high self-directed learning. Students who are taught using the problem based learning model have no interaction with students who have self-directed learning, both students with high self-directed learning and low self-directed learning.

When viewed from the self-directed learning group, the problem solving ability in the class taught using the problem based learning model is higher than that of students taught using the discovery learning model. This also happened in the low self-directed learning group, where the solving abilities of students who were taught using the problem based learning model scored higher than students who were taught using the discovery learning model. So it can be concluded that the solving abilities of students who use the problem based learning model, whether in terms of high self-directed learning or low self-directed learning, are better or better than those taught using the discovery

learning model. The absence of interaction between learning models and self-directed learning on students' problem-solving abilities is thought to be caused by the strong influence of each variable, namely problem-based learning and self-directed learning models on problem-solving abilities and discovery learning and self-directed learning models on solving abilities problem.

There are also findings that students' problem solving abilities are not just about mathematical abilities, from the findings there are students who visualize well in solving problems but are not supported by good mathematical abilities so they cannot work on questions for visualization indicators. Students whose logical and mathematical abilities are low will experience difficulties which will cause students to be unable to solve problems (Suwandi et al., 2021). Students with good mathematical abilities but not supported by visualization were also found in both the experimental and control classes.

Conclusion

Based on the results of the analysis and discussion described, it can be concluded that overall there is a significant difference in problem solving abilities between students who are taught using the problem based learning model and those taught using discovery learning, students who have high levels of self directed learning have differences in problem solving abilities. students who are taught using the problem based learning model and those who use the discovery learning model, for students who have low levels of self directed learning, there are differences in the problem solving abilities of students who are taught using the problem based learning model and those who use the discovery model and there is no interaction between learning models and self-directed learning on students' problem solving abilities.

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Author Contributions

Lisa conceptualizes research ideas, methodology design, data analysis, investigation process, writing-original draft, software, visualization, management and coordination responsibility for the research activity planning and execution. Muhammad Arsyad and Pariabti Palloan guided, wrote, reviewed and edited, supervised and validated the instruments used in the research.

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Conflicts of Interest

The authors declare no conflict of interest. The data published in this article, whether in data collection, analysis, data interpretation, in writing the manuscript or in the decision to publish research results, there is no conflict of interest for any party.

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