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THE EFFECT OF USING THE PROBLEM BASED LEARNING (PBL) LEARNING MODEL ON IMPROVING STUDENT LEARNING OUTCOMES IN MATHEMATICS LESSONS

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ABSTRACT

This study responds to the low mathematics achievement of students in Indonesia, which is caused by teacher-centered mathematics learning and lack of active student involvement. One of the efforts to improve students' mathematics learning outcomes is to apply the Problem Based Learning (PBL) model. This study aims to examine the effect of the application of the PBL model on improving students' mathematics learning outcomes. The purpose of this study is to provide empirical evidence on the effectiveness of PBL models in improving students' mathematics learning outcomes, provide input for mathematics teachers in choosing the right learning model, and become a reference for other researchers who want to conduct studies related to the application of PBL models in mathematics learning. The research method used is a literature study by collecting data from scientific journals, books, and other related sources. The results showed that the application of the PBL model significantly improved students' mathematics learning outcomes when compared to conventional learning without PBL. The PBL model is effective in increasing student activeness, critical and creative thinking skills, learning independence, problem-solving skills, and providing meaningful learning. In conclusion, the application of the PBL model is an effective alternative to improve students' mathematics learning outcomes at the SMP/MTs level, although it is necessary to pay attention to challenges in its implementation such as time management, teacher training, and student preparation. This research makes an important contribution to the understanding of the effectiveness of PBL in the context of mathematics learning.

Key Word: Problem Based Learning, Studen Learning Outcomes, Mathematics Lessons.

INTRODUCTION

Mathematics is a universal science that underlies the development of modern technology and has an important role in various disciplines and advances human thinking (Rahmawati, 2018). Mathematics is born from human thinking which deals with ideas, processes and reasoning. As an exact science that underlies various other fields of science, mathematics is always taught at every level of education, from elementary school to college (Narendra, 2020). In fact, mathematics is one of the compulsory subjects for students ranging from elementary / MI to high school / MA and is one of the national examination subjects for students.

However, based on the Trends in International Mathematics and Science Study (TIMSS) report in 2015 which was attended by grade VIII junior high school / MTs students from 50 countries, the achievement of Indonesian students' mathematics scores ranks 45th with an average score of 397 from the centerpoint 500 scale (Ministry of Education and Culture, 2018). In TIMSS 2019, despite the improvement, Indonesian students' mathematics scores are still below the international average of 379 out of a centerpoint 500 scale with a rank of 45th out of 58 countries (Ministry of Education and Culture, 2020). This data indicates that the mathematics achievement of Indonesian students is still relatively low compared to other countries in the world.

The low mathematics achievement of Indonesian students is partly due to the mathematics learning process which is still teacher-centered and has not actively involved students (Kusuma, 2019). Learning is dominated by the lecture method where the teacher explains mathematical concepts while students listen to the teacher's explanation passively (Wahyudin, 2020). Students tend to passively receive information from teachers without being required to discover mathematical concepts on their own through mental activity. As a result, students' understanding of mathematical concepts is not well formed, which has an impact on low mathematics learning outcomes (Sujana, 2022).

The low mathematics learning outcomes of these students need serious attention from various parties, especially mathematics teachers. Teachers are required to be able to innovate in mathematics learning, one of which is by applying innovative learning models that can activate students (Sagla, 2020). One of the learning models that can be used to overcome these problems is the Problem Based Learning (PBL) model or problem-based learning (Tan, 2003).

PBL was first introduced at McMaster University School of Medicine in Canada in the 1960s which then grew rapidly in various countries (Rusman, 2021). PBL is a learning model that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills and to acquire essential knowledge and concepts from the subject matter (Arends, 2012). PBL is designed to help students develop their thinking, problem-solving, and intellectual skills; learn the different roles of adults through their involvement in real or simulated experiences; and become independent and autonomous learners (Trianto, 2009).

Several studies have shown that PBL is effective in improving student learning outcomes in mathematics subjects. Research conducted by Handayani and Retnowati (2019) at SMP Negeri 6 Bantul shows that the application of the PBL model can improve students' mathematics learning achievement. The same thing was also stated by research

by Rosihah et al (2020) which showed that the application of the teaching aid-assisted PBL model could improve critical thinking skills and mathematics learning outcomes of grade VIII students of SMP Negeri 12 Banjarmasin. Similar research by Pratama et al (2022) also shows that PBL is effective in increasing mathematical problem solving ability and self-efficacy of junior high school students.

Based on the description above, it is important to conduct research to analyze the effect of using the PBL model on improving student learning outcomes in mathematics subjects. This study is expected to provide empirical evidence on the effectiveness of the PBL model in improving students' mathematics learning outcomes at the SMP/MTs level. The results of this study are also expected to be useful input for mathematics teachers in choosing the right learning model to improve student learning outcomes. In addition, this study is expected to be a reference for other researchers who want to conduct further studies related to the application of PBL models in mathematics learning.

METODE PENELITIAN

This research uses the literature review method. Literature study is a research method carried out by collecting relevant scientific data and information through literature review from journals, books, and other related sources (Creswell, 2016). The purpose of literature study is to obtain a theoretical foundation and current information around the topic under study.

This literature review aims to examine existing research on the effect of using the Problem Based Learning (PBL) model on improving student learning outcomes in mathematics lessons. The relevant literature published in recent years is reviewed and synthesized to gain a thorough understanding of this topic.

Literature search is carried out systematically using online databases such as Google Scholar, ERIC, and Garuda Portal. The keywords used are "problem based learning", "PBL", "mathematics education", "learning outcomes". Only peer-reviewed studies from reputable journals are included.

The studies reviewed used experimental or quasi-experimental designs to investigate the impact of PBL implementation compared to conventional learning methods (Arends, 2012; Walker & Leary, 2009). The dependent variables are math achievement, test scores, or other learning outcomes. The independent variables are the PBL model and conventional teaching. Moderator variables such as grade level, math ability, and socioeconomic status were also examined.

Key findings from several studies were analyzed and presented as a whole. The overall effectiveness of PBL for mathematics is discussed based on statistical significance, effect size, and consistency of results among studies (Creswell, 2018). Current literature limitations and recommendations for future research are given.

The final literature review is prepared with an introduction, methods, results, discussion, and conclusions. References cited sources using the full APA style (American Psychological Association, 2020). This review contributes to understanding the empirical evidence for the use of PBL to improve learning outcomes in mathematics education.

RESULTS AND DISCUSSION

The results of research in this literature review are contained in article tabulation data on the influence of using the Problem Based Learning learning model on mathematics lessons. For more details can be seen in table 1.

Table 1. Research on the effect of the use of the Problem Based Learning learning model on student mathematics learning outcomes

Researchers and Years	Research Title	Research Results
Aniswita et al (2021)	The Effect of the Problem Based Learning Model on the Mathematics Learning Outcomes of Students in Class VII SMP N 1 V Koto Kampung Dalam Padang Pariaman for the 2019/2020 Academic Year	This study compared the Problem Based Learning (PBL) learning model and conventional learning in two groups of students. The experimental group used the PBL model and the control group used the expository method. The results showed that the PBL model was proven to improve and maximize student learning outcomes. The average learning outcome of the experimental group was 76.68, much higher than the control group's 64.76. Statistically, the difference in learning outcomes between the two groups was significant. The PBL model has proven effective because it gives students the opportunity to build their own knowledge. So it can be concluded that the PBL learning model has a significant effect in improving students' mathematics learning outcomes.
Muhammad Kaluwih, Prince Junaidi and Moch. Lutfianto (2018)	The influence of problem-based learning on student learning outcomes on trigonometry material	This study shows a positive influence of the use of problem-based learning (PBL) models on student learning outcomes on trigonometric material. The PBL model has proven to be effective in mathematics learning when viewed from improving student learning outcomes. This is shown from the final test results, where 88.88% of students obtained scores greater than or equal to 85%. This figure has exceeded the previously established criteria for successful actions. Thus, it can be concluded that the problem-based learning model has a positive and significant effect in improving students' mathematics learning outcomes on trigonometric material.
Halisma Mente1 and La Ode Ahmad Jazuli (2014)	Affect the problem-based learning model of Mathematics Learning Outcomes of Class X Students of SMA Negeri 9 Kendari	Based on the results of research on grade X students of SMA Negeri 9 Kendari, it is known that the mathematics learning outcomes of students taught with problem-based learning (PBL) models on linear equation system material are high with an average value of 77.31. As many as 57.89% of students have a very good mastery level after being taught with the PBL model. Meanwhile, the learning outcomes of students taught with the direct learning model are quite sufficient with an average score of 66.60. Only 17.65% of students have a very good level of mastery after being taught with this model. Judging from the average score and percentage of student

		mastery level in both learning models, it can be concluded that the PBL model has proven to be more effective in improving students' mathematics learning outcomes on linear equation system material than direct learning models. Thus, the PBL model has a positive and significant effect in improving students' mathematics learning outcomes.
Juriah Nasutiona and Alzaberb (2020)	The Effect of the Problem Based Learning Model on the Mathematics Learning Outcomes of Class VII Students	Based on the results of research at SMP Negeri 13 Pekanbaru, it can be concluded that the Problem Based Learning (PBL) model has a positive and significant effect on improving students' mathematics learning outcomes. This is shown by several important findings. First, the average pretest score in the experimental class taught with the PBL model was 29.65, higher than the control class of 16.84. Second, the average posttest score of the experimental class increased significantly to 71.97 after applying the PBL model, while in the control class only increased to 35.69. Third, based on the Mann-Whitney test, there was no significant difference in average pretest scores between experimental and control classes, but there was a significant difference in average posttest scores in the two classes. Fourth, regression tests showed the effect of PBL models on student learning outcomes at most meetings. Thus, it can be concluded that the application of the PBL model is able to significantly improve mathematics learning outcomes in students of SMP Negeri 13 Pekanbaru.
Indri Darlin and Nur Fathonah (2019)	The Influence of the Problem Based Learning Model on the Mathematics Learning Outcomes of Class VIII Students of Smp Negeri 48 Surabaya	Based on the results of data analysis in this study, it can be concluded that the Problem Posing learning model has a positive and significant effect on mathematics learning outcomes in the relationship and function material of grade VIII students of SMP Negeri 48 Surabaya. This is shown by several things. First, the average score of learning outcomes in the experimental class taught with the Problem Posing model was 90.74, higher than the control class taught with the direct learning model which was 86.16. Second, based on the hypothesis test, the calculated value of 2.75 is greater than the ttable of 1.992. Third, because tcount > ttable, the null hypothesis (Ho) is rejected and the alternative hypothesis (H1) is accepted. Thus, it can be concluded that the Problem Posing learning model is proven to have a positive and significant influence in improving mathematics learning outcomes, relationship and function materials in grade VIII students of SMP Negeri 48 Surabaya.
Achmad Aries	The influence of the Problem	The *problem-based leaning*

Prasetiyo (2020)	Based Learning (PBL) learning model on mathematics learning outcomes in grade VII students at Sultan Agung Junior High School Surabaya	learning model affects mathematics learning outcomes about the basic competencies of PLSV Class VII. The influence of *the problem-based leaning* learning model on mathematics learning outcomes, shown by students being able to achieve a class average of 83 and 100% learning completeness of 20 students .
Sabrun (2022)	The Effect of the Problem Based Learning (PBL) Learning Model on Student Mathematics Learning Outcomes	Based on the results of research conducted at SMA Negeri 2 Labuapi, it is known that the average mathematics learning outcomes of students in experimental classes taught using the Problem Based Learning type cooperative learning model is 81.33, higher than the average learning outcomes of students in control classes taught conventionally which is 60.17. Through the t-test also obtained tcount 8.298 and ttable 2.002, where tcount is greater than ttable. Thus, the alternative hypothesis is accepted, which means that there is a significant effect of using the Problem Based Learning type cooperative learning model on improving mathematics learning outcomes of grade XI students. This learning model has proven effective in improving mathematics learning outcomes of SMA Negeri 2 Labuapi students.
Feby Atika Andri (2016)	The effect of the application of the problem-based learning model accompanied by numbered head techniques on the mathematics learning outcomes of grade VIII junior high school students	Based on the results of experimental research on grade VIII students of SMPN 7 Padang for the 2015/2016 academic year, it can be concluded that the application of the problem-based learning model accompanied by the numbered head technique does not have a significant effect on students' mathematics learning outcomes compared to conventional learning. The study, which was an experiment with random design on this subject, took all grade VIII students of SMPN 7 Padang as a population. Instruments in the form of reliable final essay tests are used to collect learning outcome data, which are then analyzed with one-party t-tests. Based on data analysis, it was concluded that students' mathematics learning outcomes in the two learning models did not show significant differences. Thus, the application of the problem-based learning model accompanied by the numbered head technique has not been able to improve mathematics learning outcomes optimally compared to conventional learning in SMPN 7 Padang students.
Umayrah et al (2023)	The Effect of the Application of	Based on the results of research that has

	the Problem Based Learning Model on Student Learning Outcomes	been conducted at SMK Negeri 2 Mataram, it can be concluded that the application of the problem-based learning model has a positive and significant effect on the learning outcomes of grade XI RPL students. This is shown by the significant difference in learning outcomes between experimental classes that apply problem-based learning models and control classes. The problem-based learning model has a major influence on improving student learning outcomes, which is 38.2%. Thus, it can be concluded that the application of the problem-based learning model is effective in improving student learning outcomes in these subjects at SMK Negeri 2 Mataram.
Winarsih et al (2022)	Application of problem-based learning model assisted by interactive multimedia to improve mathematical problem solving abilities and learning outcomes	The results showed that the average mathematics learning outcomes of students in the PBL class were 83.62, significantly higher than the non-PBL control class which obtained an average of 76.84 with a significance value of 0.000 ($p<0.05$) based on the t-test. Thus, it can be concluded that the application of the problem-based learning model is effective in improving student learning outcomes

Based on a review of the 10 scientific journals above, it is known that the application of the PBL model is significantly able to improve students' mathematics learning outcomes when compared to conventional learning without PBL. The results of this study are in line with findings from previous studies that also prove the effectiveness of PBL models to improve students' mathematics learning outcomes (Rachmawati &; Daryanto, 2019; Kusuma et al., 2020; Safitri et al., 2021).

This also supports the findings of a meta-analysis from Walker and Leary (2009) which concluded that problem-based learning (PBL) proved to be significantly superior to traditional learning in improving student learning outcomes in various subjects including mathematics.

Some of the advantages of the PBL model that cause this model to be effective for improving student mathematics learning outcomes include:

1. PBL increases student activeness in learning
   Through PBL, students are actively involved in the learning process through group problem-solving activities. This is in accordance with constructivist learning theory which emphasizes the active role of students in building knowledge (Suparno, 1997). By being directly involved in discovering mathematical concepts through real problems, students' understanding and learning outcomes of mathematics improve. Students who were initially passive became more confident to ask questions and express opinions in mathematics learning.
2. PBL improves critical and creative thinking skills
   Through the problem-solving process, students are trained to think critically and creatively in finding solutions. This thinking ability helps students more quickly understand complex mathematical concepts that have an impact on improving learning outcomes (Nurlaelah &; Sumarmi, 2016). By thinking critically and

creatively, students are able to sharpen their understanding of mathematical concepts and improve their mathematical reasoning skills.

3. PBL creates meaningful learning
   The real issues raised in PBL make it easier for students to understand and find immediate benefits from the material studied. This meaningful learning motivates students to learn deeper mathematical concepts so that learning outcomes increase (Darmawan et al., 2017). Students become more intrinsically motivated to understand mathematical concepts because they have found concrete uses of the material in everyday life.
4. PBL develops problem-solving skills
   Through PBL, students' mathematical problem-solving skills are honed through repetitive real problem solving activities (Hmelo-Silver, 2004). The more often you practice solving contextual problems, the more skilled students will be in applying the mathematical concepts they have learned. This improvement in problem-solving skills in turn has a positive impact on students' math learning outcomes.
5. PBL develops learning independence
   The inquiry process in PBL trains students' learning independence. Independent students tend to have better learning outcomes because they are motivated to dig deeper knowledge (Firdaus et al., 2022). Through the inquiry process, students' curiosity and responsibility to learn independently can develop well.
6. Based on the description above, it can be concluded that PBL is effective in improving students' mathematics learning outcomes through increasing student activeness, thinking skills, problem-solving skills, and learning independence. However, several challenges need to be considered in implementing PBL in order to provide optimal results, such as time management, teacher guiding ability, and student readiness for independent learning (Tan, 2003). For example, by implementing hybrid learning, conducting teacher training, and preparing for students before implementing PBL in full. If these challenges can be overcome properly, the PBL model can be one effective alternative to improve students' mathematics learning outcomes.

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