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The Impact of a Problem-Based Learning Model on Students' Ability to Solve Mathematical Problems

Hera Cahyawati [1)], Mohamad Salam [1)], Salim [1)*]

[1]Department Mathematics Education, Universitas Halu Oleo. Jl. HEA. Mokodompit Kampus Hijau Bumi Tridharma Andounohu, Kendari City, Indoensia.

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Abstract

The goal of this study was to ascertain whether the problem-based learning (PBL) instructional paradigm had an impact on the students in class VIII at SMP Negeri 17 Kendari's ability to solve mathematical problems. All eighth grade students from SMP Negeri 17 Kendari, which has 7 classes, from VIII1 to VIII7, made up the population for this study. Purposive sampling methods were used to choose class samples as treatment groups by taking into account the average value and variation of the outcomes of students' arithmetic midterm exam scores. Simple randomization was used to create two classes from the two existing class groups: VIII1 as a control class taught using a team-assisted individualization learning model and VIII7 as an experimental class taught using a problem-based learning model. These two classes will be used as research samples. The findings of the observation sheet, exams that gauge students' capacity for solving mathematical problems, and questionnaires serve as the basis for the analysis of the data. The findings of this study show that the problem-based learning paradigm has an impact on students in class VIII at SMP Negeri 17 Kendari's ability to solve mathematical problems.

Keywords: *mathematical problem solving; problem based learning*; *team assisted individualization*.

INTRODUCTION

From elementary school through junior high and even high school, we have studied math skills that are crucial to all facets of life and particularly help each student's abilities. Junior High School students have learnt about logic, manipulation, and even making conclusions in mathematics lessons. Students that study math in school might uncover facts, concepts, and principles to use in their reasoning to answer an issue. The truth is that a lot of pupils still view math as one of the more challenging courses. Problem solving is a necessary component of arithmetic learning, claims (Effendi, 2012). According to the objectives of the National Council of Teachers of Mathematics, teachers must focus on the five mathematical skills that students need to possess in order to learn mathematics, namely: connection skills, reasoning skills, communication skills, problem-solving skills, and representation skills (Riswanto, 2016). Because teachers play a crucial role in developing students' abilities, particularly in mathematics learning, which necessitates the development of problem-solving skills, by using an appropriate learning model or by developing problems that support the students' mathematical problem-solving abilities.

Problem-solving as a method or approach to be able to address the current issue in order to use appropriate and effective methods to reach the desired outcomes (Febriyanti, 2017). By using their abilities to the point where it necessitates critical and creative thought, students can overcome challenges in addressing problems that are categorized as difficult by developing their problem-solving skills. The ability to solve problems is a necessary talent for students to have (Sumarmo, 2017), as it is a general learning objective, a core process in the mathematics curriculum, and a component of learning the

*Correspondence Author. E-mail: salimpsa@gmail.com
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fundamentals of mathematics. Understanding the problem, creating a strategy, putting the plan into action, and verifying again are the stages or processes of problem-solving techniques employed in this study (Mustika & Devi, 2019). This is done to improve pupils' problem-solving abilities, particularly their ability to complete math problems quickly and correctly (Yuwono, 2010).

Class VIII arithmetic at SMP Negeri 17 Kendari has a standard Minimum Completeness Criteria value of 70.00, however students' midterm exam scores over the past two semesters have averaged 66.92, with 55.75% of all students receiving grades below the KKM. This is due to the fact that some students were preoccupied with their own tasks during the discussion process and did not pay attention to what the teacher was discussing. One of the students' low abilities, particularly their aptitude for solving mathematical problems, is another factor contributing to the low student learning outcomes. Researchers' interviews with math teachers revealed that pupils' ability to solve mathematical problems, particularly math difficulties, was still severely weak. This is due to the fact that the indicators of students' problem-solving skills are not met. For example, one indicator of students' mathematical problem-solving skills that is unfulfilled is understanding the problem, as knowing the problem is a prerequisite for solving it.

The results of researchers' observations on the answers to students' worksheets, where several groups work on it without understanding the problem or the conditions of the problem in the students' worksheets, so that when writing answers students do not write what is known, what is asked, do not write the formula as a planning desig., also show that students have a low ability to solve mathematical problems. These steps—understanding the issue, making plans to address it, and even checking back in the form of conclusions—are all included in the problem-solving skill indicators. So it is clear that not all of the markers of problem-solving skill are met. Therefore, it can be claimed that students still struggle to solve mathematical problems.

The use of learning models that are inappropriate for enhancing students' capacity for solving mathematical problems is another element that contributes to their poor mathematical problem-solving skills. At SMP Negeri 17 Kendari, the 2013 curriculum is being used to implement a scientific approach to learning. The Team Assisted Individualization (TAI) learning model was the one the prior teacher employed. issues that are poorly understood. so that instruction continues to center on the teacher. The team assisted individualization learning paradigm, according to Lestari and Ridwan (2017), examines individual capacities but through group learning stages or one-on-one help in groups. The level of student ability, religion, and race are taken into consideration when dividing students into the 4-5 diverse groups that make up the team-assisted individualization model (Riswanto, 2016).

Each student will individually acquire the content that has been provided by the teacher under the team supported individualization learning approach. The outcomes of each student's learning will then be presented to the group, where they will be discussed and each group member will be held accountable for the solutions they offer as a kind of shared accountability (Tristanti, 2017). The steps of the TAI type cooperative learning model are as follows: (1) Placement test, which involves administering a test to pupils in order to place them according to their strengths and weaknesses, but as determined by report cards or prior test results; (2) Teams, where students are divided into a variety of diverse groups of 4-5 students, with at least one high-ability (clever) student in each group; (3) Student creativity, which entails completing class work in groups to establish a scenario in which an individual's performance influences the success of the group; (4) Team study, which is group learning wherein intelligent students assist their other group members one-on-one during the learning process so that there is a conversation process in a study group.

The teacher will then offer each student who requires it personalised support: (5) Team scoring and team recognition, which entails awarding high-scoring teams and assigning scores to each group for the task they have completed; (6) Teaching group, where the instructor provides a succinct explanation of the subject; (7) Fact test, which involves giving students feedback or reflection based on the information they have learned; (8) Whole-class unit, which involves giving a summary of the material at the conclusion of the learning process..

Although the SMP Negeri 17 Kendari school has used a cooperative learning model, in reality, students rarely ask the teacher questions about content that they find difficult, necessitating the use of a creative learning model that can improve students' ability to think more critically and increase their learning activities. One of the models that can be selected is the problem-based learning model, which is one of the useful learning models used in improving students' mathematical problem solving abilities. The problem-based learning model itself in the learning process always confronts students with good problems in the form of problems, so if students are frequently faced with problems or get used to solving math problems, their thinking skills will increase which will also affect st Because they will be concentrated on solving the problems or arithmetic problems that the instructor assigns, it will result in student-focused learning and the teacher will just monitor learning. According to (Jiniarti et al., 2015), problem-based learning models are those that constantly provide students with a variety of real situations that call for meaningful research. The issue-based learning methodology teaches students to tackle a problem critically and creatively, per (Oktaviani et al., 2018). Meanwhile, (Sumartini, 2016) underlines the importance of the problem-based learning paradigm in helping students develop their critical thinking, intellectual, and problem-solving abilities.

This study supports the findings of (Liani et al., 2018).'s study, which was conducted at SMAN 3 in Bengkulu City. During the learning process, the teacher had previously used the discussion method, which led to a number of issues, including students who weren't paying attention, others who weren't aware of the topics being covered, and it was evident that some students who were falling behind were preoccupied with other activities. Additionally, the teacher's chosen learning strategy does not help students get better at solving mathematical puzzles. Consequently, selecting a problem-based learning approach will help students' ability to solve mathematical problems. Considering that the problem is at the heart of problem-based learning.

The problem-based learning approach can help students become more curious and motivated, which has a significant impact on the learning process overall and on teachers' roles in particular. Where the teacher acts as a facilitator of learning by supervising the learning process and helping pupils understand the value of learning, in addition to providing the necessary materials (Palaloang, 2014). As stated by (Sugiarti & Basuki, 2014), the problem-based learning approach also contains the following characteristics: (a) learning starts with offering tough problems; (b) students work in small groups with a variety of skills; and (c) the instructor has a role as a facilitator in learning. The goal of the problem-based learning paradigm, according to (Kristandi et al., 2018), is to help students think critically, logically, and methodically while also helping them identify the best solution to the problem at hand. The goals of the problem-based learning model, according to (Rusman, 2017), are to: (a) assist teachers in giving students as much information as possible; (b) support students in developing their intellectual, thinking, and problem-solving skills; and (c) help them become independent and self-sufficient learners.

According to (Sumantri, 2016), the syntax of the problem-based learning model is as follows: (1) orienting students to the problem; the teacher's activities at this point include explaining the learning objectives, using tools and materials during the learning process,

providing or suggesting a story that raises a problem; and motivating students so that they are interested in solving the problems they have chosen; (2) preparing pupils for learning; at this phase, the teacher aids students in planning or defining learning assignments associated with the issues they experience; (3) supervising group and individual investigations, which are tasks carried out by the teacher at this stage, in which the teacher encourages students to gather relevant data and helps them conduct experiments to find explanations and problem-solvers; (4) creating and presenting work, which are activities carried out by the teacher at this stage, namely the teacher assists students in organizing and preparing the work they have obtained in the form of reports, models, and videos that will then be presented to other groups; (5) analyzing and evaluating the problem-solving process, which are activities carried out by the teacher at this final stage, namely the teacher assists students by providing evaluation or reflection on the investigation process that was conducted;

This study's goal was to ascertain how the problem-based learning (PBL) instructional paradigm affected the class VIII students at SMP Negeri 17 Kendari's ability to solve mathematical problems..

RESEARCH METHODS

This study employs a quantitative methodology to describe the impact of the problem-based learning paradigm using a quasi-experimental form of research. The population for this study consisted of all eighth-graders at SMP Negeri 17 Kendari. Purposive sampling was used to choose the group sample for this study, and the average value and variation of the students' math midterm exam scores were taken into account. Two classes, VIII1 as a control class taught using the team assisted individualization learning model and VIII7 as an experimental class taught using the problem-based learning model, were obtained and would be used as research samples. The experimental class and control class were determined by simple randomization in the form of a draw. In this study, a posttest-only control group with a single kind of treatment was used.

Table 1. Research Plan

Group	Treatment	Posttest
R	X_1	O_1
R	X_2	O_2

This study uses three different types of instruments: observation sheets, assessments of one's aptitude for solving mathematical problems, and questionnaires. In the experimental class that was taught using the problem-based learning model and the control class that was taught using the team supported individualization learning model, the activities of students and teachers during the learning process were recorded on the observation sheet at each meeting. The mathematical problem-solving test is used to assess students' degree of proficiency while the questionnaire is utilized to ascertain students' opinions regarding the application of problem-based learning models to flat-sided space construction materials.

In order to analyze the usefulness of student questionnaires, this study makes use of a modified version of a questionnaire (Kholidah, 2015; Burhanudin, 2019). (Purnamasari & Himmawati, 2017). The following formula was used to examine the results of a student response questionnaire: (Giyantono, 2013).

$$P = \frac{F}{N}\ x\ 100\ \% \quad \text{.....(1)}$$

The following table provides criteria for the percentage outcomes of student and teacher responses (Giyantono, 2013).

Table 2. Standards for Student Response Questionnaire Percentage Results

Percentage (%)	Description
$0 \leq P \leq 20{,}5$	Very Poor
$21 \leq P \leq 40{,}5$	Poor
$41 \leq P \leq 60{,}5$	Simply
$61 \leq P \leq 80{,}5$	Good
$81 \leq P \leq 100$	Very Good

Data on pupils' propensity for solving mathematical problems is collected using examinations that gauge this propensity, and the data is then processed through descriptive and inferential analysis. In this study, descriptive analysis is used to describe the sample's condition using percentages (%), averages, medians, modes, standard deviations, variances, skewnesses, kurtosis, maximum values, and lowest values. Using the reference table provided by the calculation, the level of mathematical problem-solving aptitude is subsequently classified (Ariani et al., 2017).

Table 3. Category of Students' Capability to Solve Mathematical Problems

Student Score	Rating Category
81,00-100	Very Good
61,00-80,99	Good
41,00-60,99	Simply
21,00-40,99	Poor
0,00-20,99	Very Poor

RESULTS AND DISCUSSION

This study was carried out at SMP Negeri 17 Kendari after a teacher of mathematics was interviewed after being first observed at the institution. Researchers discovered issues experienced by teachers and pupils from the interview's findings. Not meeting the established KKM and having poor quantitative problem-solving abilities, particularly in arithmetic, are some of the issues that pupils deal with. Low mathematical problem-solving abilities among pupils will have an impact on their ability to learn. Inappropriate learning models are another issue that teachers deal with. The learning process will be impacted by the choice of the learning paradigm. Because of some of the issues encountered, researchers decided to conduct their investigation at SMP Negeri 17 Kendari school. A problem-based learning paradigm is one that requires students to actively participate in solving the current problem after they are presented with it during the learning process. However, the team assisted individualization learning model blends cooperative learning with the use of individuals' strengths in a group.

The control class and experimental class both participated in the execution of this lesson over the course of eight meetings. 6 sessions are used to conduct face-to-face instruction, and 2 meetings are used to administer examinations to assess students' aptitude for solving mathematical problems and to administer questionnaires to assess students' comprehension of the information covered in the problem-based learning paradigm. The purpose of the test is to assess students' capacity for solving mathematical problems in the experimental class and control class following therapy.

Because there were still several steps of the learning model that had not been executed by both teachers and students, the percentage of success in the learning outcomes acquired

using the problem-based learning model fluctuated from the first meeting to the sixth meeting. Similarly, the number of students using the team-assisted individualization learning model increased, perhaps as a result of the previous teacher's application of this learning strategy. Table 4 below shows the findings of the descriptive analysis of students' test scores on their capacity to solve mathematical problems.

Table 4. Describes Students' Capacity For Solving Mathematical Problems

Descriptive Statistics	Experiment Class	Control Class
Jumlah Sampel	30	29
Mean	67,88	53,77
Median	72,91	52,08
Std. Deviation	13,496	12,335
Variance	182,148	152,174
Minimum	38,54	31,25
Maximum	89,58	82,29

According to table 4, students in the experimental class, which was taught using the problem-based learning model, were better able to solve mathematical problems than those in the control class, which was taught using the team-assisted individualization learning model. This suggests that, as compared to the team-assisted individualization learning model, the problem-based learning approach can significantly improve students' ability to solve mathematical problems. The posttest data from the experimental class taught using the problem-based learning model had a higher variance than the posttest data from the control class taught using the team supported individualization learning model, according to the indicator of data diversity (variance). The variance value between the two groups demonstrates that students in the experimental class had a wider range of mathematical problem-solving skills than those in the control group. In terms of the indicators of maximum value, minimum value, median, mean, and standard deviation, the posttest results of the experimental class's pupils' capacity to solve mathematical puzzles are superior to those of the control class. Therefore, it can be concluded that students in the experimental class who were taught using the problem-based learning model were better at solving mathematical problems than those in the control class who were taught using the team assisted individualization learning model. Table 5 below shows the dispersion of students' ratings for their capacity to solve mathematical problems.

Table 5. Score Distribution for Students' Capability to Solve Mathematical Problems

No	Rate	Category	*Problem based learning*		*Team Assisted Individualization*	
			Frequency	%	Frequency	%
1	81,00-100	Very Good	3	10	1	3,45
2	61,00-80,99	Good	20	66,67	6	20,69
3	41,00-60,99	Simply	6	20	18	62,07
4	21,00-40,99	Poor	1	3,33	4	13,79
5	0,00-20,99	Very Poor	0	0	0	0
Jumlah			30	100	29	100

According to Table 5, which displays the findings of a descriptive analysis, students who are taught using a problem-based learning model are better at solving mathematical problems than those who are taught using a team-assisted individualization learning model when using flat-sided space building materials. The degree of students' mathematical problem

solving is distributed among the categories of very good, good, sufficient, less, and very less, according to the distribution of posttest scores in the class taught using the problem-based learning approach. 20 kids were in the good category, 6 students were in the sufficient category, 1 student was in the less category, and there were no students in the very less category. A total of 3 students fell into the very good group. This is due to the fact that, according to the analysis of the posttest results, students are able to solve problems by meeting all indicators of problem-solving competence by grasping the problem (writing what is known and asked), creating a problem-solving plan, carrying it out, and checking back in the form of conclusions. However, there was only one student in the very good category, six in the good category, eighteen in the sufficient group, four in the less category, and none in the very less category in the control class. This is due to the fact that the majority of the control class failed to provide the correct response, failed to comprehend the problem initially (by failing to record what was known, what was asked, and the completeness of the data), failed to develop a plan, failed to carry out the problem-solving plan, and failed to recheck.

According to the findings of the inference analysis test related to the normality and homogeneity tests, the data on mathematical problem-solving skills of students taught using the problem-based learning model and the data on these skills of students taught using the team-assisted individualization learning model are both normal and homogeneous.

Table 6. Results of Student Mathematical Problem Solving Ability Data's Normality and Homogeneity Tests

Group	Normality Test		Uji Homogenitas	
	Sig.(2-tailed)	**Decisions**	***Sig.***	**Decisions**
Experiment	0,101	Terima H_0	0,644	Terima H_0
Control	0,925	Terima H_0		

Table 7 below shows the findings of a hypothesis test about the difference between students taught using the Problem-based Learning model and Team Assisted Individualization learning model in terms of the average ability of each group to solve mathematical problems.

Table 7. Data Hypothesis Test Analysis Results

t Count	$\frac{sig.(2-tailed)}{2}$	Decisions
4,188	**0,000**	**Reject H_0**

Based on table 7, the results of the t-test analysis obtained the value of t_{count} is 4,188 > t_{table} with $t_{(0,05,\ 30+29-2)}$ = 1,672 and value $\frac{sig.(2-tailed)}{2}$ is 0,000 < α = 0,05 then H_0 is rejected. This indicates that in class VIII at SMP Negeri 17 Kendari, students taught using the problem-based learning model have a higher aptitude for solving mathematical problems than those taught using the team-assisted individualization learning model. The rejection of H_0 demonstrates that the problem-based learning paradigm has a better impact on the ability of students in class VIII at SMP Negeri 17 Kendari to solve mathematical problems. This is due to the fact that students in the experimental class who were taught using a problem-based learning model did a better job of solving mathematical problems than those in the control class who were taught using a team-assisted individualization learning model. The problem-based learning methodology has an impact on students' abilities to solve mathematical problems. This is consistent with Gegne's learning hypothesis that problem-solving is a powerful method for developing high-level cognitive abilities, such as mathematical reasoning (Liani et al., 2018). Additionally, according to earlier studies by (Mulyawati et al., 2017) and (Gunantar et al., 2014), utilizing a problem-based learning strategy can help

students become better at solving mathematical problems. This demonstrates that the use of the Problem Based Learning paradigm has a substantial impact on enhancing the ability of students in class VIII at SMP Negeri 17 Kendari to solve mathematical problems.

When researchers have used the two learning models, it is possible to see the differences between the problem-based learning model and the team-assisted individualization learning model. According to learning activities conducted in the classroom, students appear more interested and active during learning activities in experimental classes taught using problem-based learning models. This is because the problem-based learning model is a new model acquired by students. Students in the control class who were taught using the team aided individualization learning model appeared less interested in the learning process and felt bored because the teacher had already implemented the team assisted individualization learning model in that class. This is what makes a learning process successful.

The effectiveness of a learning process at school to enhance pupils' mathematical problem-solving abilities is influenced by a number of factors, one of which is the employment of an inappropriate learning model. Therefore, the problem-based learning paradigm is an effective method for enhancing students' capacity for solving mathematical problems. This is consistent with what (Nadhifa, 2016) discovered, which is that during the learning process, teachers typically only deliver material based on the textbooks they use, preventing opportunities for students to develop their skills so that it will have an impact on their problem-solving abilities. underdeveloped. Innovating the learning model to be utilized in order to make it the problem-based learning model is one of the attempts made to help students become better at solving problems.

Although there were some challenges the teacher faced during the learning process, such as some students who chose to remain silent when asked or did not want to give an opinion, learning in the experimental class taught using the problem-solving learning model was better than learning in the control class taught using the team assisted individualization learning model. Additionally, learning in the experimental class was superior to the control class since the control class's pupils were bored and some were spotted playing in the back when the teacher gave them assignments, notably in the experimental class's case. Because of the teacher's use of a problem-based learning model in the experimental class, which required students to solve a problem that was presented by the teacher, students were more actively involved in the learning process, from understanding the problem to planning a solution to checking back by drawing conclusions. Additionally, based on what they learn, students in experimental classes tend to be more engaged in working on LKPD. Because of this, students in the experimental class using the problem-based learning model are better at solving mathematical problems than those in the control class using the team-assisted individualization learning model. Students responded very favorably or positively to the use of problem-based learning models, according to the results of surveys that were given to them.

The problem-based learning approach encourages students to think critically both alone and in groups, take an active part in their education, solve problems, and derive the appropriate conclusions or solutions from a given situation. Students will thus be better prepared to come to suitable conclusions and answers while tackling difficulties. According to research by (Liani et al., 2018), adopting the brainstorming approach along with a problem-based learning model requires students to have an active role in issue solving and constructing the information in the form of new knowledge. The conclusion drawn from this study is that utilizing a problem-based learning model has a positive impact on students' ability to solve mathematical problems, or that using a problem-based learning model is preferable to using a team-assisted individualization learning model. Thus, by paying attention to the applicability

of the content, teachers can use the problem-based learning model as one of the learning models to help students become more adept at solving mathematical problems.

A strong student response survey that comprises comments from respondents expressing satisfaction with the mathematical instruction provided by the teacher further supports the achievement of learning in the experimental class. When the teacher used the problem-based learning strategy in the experimental class, the students responded fast and grasped the subject. When a teacher uses a problem-based learning approach to educate, the pupils do not feel bored and are more engaged. This demonstrates that the problem-based learning approach has a beneficial impact on students' level of comprehension of flat-sided space building materials.

CONCLUSIONS AND SUGGESTIONS

It is clear from the research and discussion findings in this study that the problem-based learning paradigm has a positive impact on students' ability to solve mathematical problems in class VIII at SMP Negeri 17 Kendari. Several recommendations are made through this conclusion, including: (1) It is anticipated that teachers at SMP Negeri 17 Kendari school, particularly those who teach mathematics, will use the problem-based learning model to maximize the development of students' mathematical problem-solving abilities; (2) Given the number of restrictions and flaws in the problem-based learning models' learning processes that have not been maximized in this study, it is hoped that future research will examine how to improve these processes.

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