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Implementation of The Problem-Based Learning Model to Improve Students' Mathematical Problem-Solving Abilities

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Abstract

The low mathematical problem-solving abilities of Indonesian students can be seen from the PISA test results, which show that Indonesian students are ranked 72nd out of 78 countries, with an average score of 394 in 2018. Using Problem-Based Learning, this classroom action research seeks to improve the learning process and increase students' mathematical problem-solving abilities. This research was attended by 41 students with various skill levels from class VIII 3 of SMP Negeri 17 Pekanbaru. This research was divided into two cycles, each consisting of four stages: preparation, implementation, observation, and reflection. Research instruments include learning tools and instruments for collecting data. The KPMM test instruments and observation sheets are data collection instruments, while the syllabus, learning implementation plans, and student worksheets are learning tools. Data from observation sheets and mathematical problem-solving ability tests were examined using descriptive analysis techniques. From cycle I to cycle II, the learning process, according to observation data, experienced improvement. In cycle II, the average value of students' mathematical problem-solving abilities increased from 55.97 in cycle I to 81.09. By implementing Problem Based Learning in the learning process, the mathematical problem solving abilities of class VIII3 students at SMP Negeri 17 Pekanbaru have increased and improved their learning process. So researchers highly recommend this learning model in improving the learning process and increasing students' KPMM.

INTRODUCTION

The National Council of Teachers of Mathematics (NCTM) mandates that students must have five abilities in mathematics: problem-solving ability, communication, connections, reasoning, and representation [1]. Mathematics problem-solving abilities (KPMM) are one of the elements of primary education emphasized by the Mathematics Ministry of Education and Culture [2]. The problem of solving is impossible to separate from learning mathematics because mathematics is an essential component [1]. Yarmayani [3] explains that KPMM is the ability of a student to find a solution to reach purpose. This needs readiness, creativity, knowledge, and skills that must be used daily. The fact that problem-solving is (1) the primary purpose of teaching mathematics; (2) composed of methods, procedures, and strategies that are the core and central processes in the curriculum; and (3) involves skills in mathematics base strengthens Branca's

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statement [4]. According to Polya [5], there are four necessary steps done to finish a problem: (1) understanding the problem; (2) planning the problem-solving; (3) carrying out plan solve problems; and (4) observing the problem until complete. According to perspective, KPMM is a necessary skill owned by students because, with skills, this is very capable of solving problems and improving and impacting the results of study in other studies and real-world situations.

The Program for International Student Assessment (PISA) is one of the exam international exams that can be referenced to ensure to what extent a person's KPMM level students. The PISA test tool is a problem that requires skills in spatial, logical, or solve problems [6]. The questions given by PISA require settlement not only by remembering but also by analyzing and solving problems [7]. Ability mathematics Indonesian students are ranked 72nd out of 78 countries with an average score of 394 on the 2018 PISA assessment, far lower than the world position of 489. The low KPMM of Indonesian students is visible from the test results. This is the first objective of the KPMM test. This evaluates the student KPMM level in class $VIII_3$ SMPN 17 Pekanbaru. KPMM students were evaluated using criteria for the KPMM evaluation proposed by Ali Hamzah [8]. The criteria are based on four KPMM indicators: understanding the problem, planning the problem solving, implementing the plan, and evaluating results. Findings child KPMM measurement class VIII $_3$ SMPN 17 Pekanbaru presented in Table 1 below:

Table 1. Percentage of Students received Maximum Scores for Each KPMM Indicator

No	KPMM Indicator	Amount participants educate For every indicator (JM)	Percentage participant learners who can fulfill score maximum on each indicator $\left(\frac{JM}{41} \times 100\%\right)$
1	Understand problem	24	58.54%
2	Plan problems solving	2	4.87%
3	Carry out plan problems solving	7	17.07%
4	Interpret results obtained	1	2.43%

Source: Processed Data Researcher 2023

Table 1 shows that the KPMM of students is Still low and Incapable of obtaining marks as high as possible at every indicator. At SMPN 17, Pekanbaru did observation and interview about the importance of KPMM to mathematics teachers and students. The interview was done with three students. Students say that mathematics is difficult and tedious, and the learning process of mathematics is rated monotonous because learning is done with the teacher explaining in front of the class and rarely in a discussion group. Participant 1 wants to ask if he does not understand learning because of feelings of shame and the assumption that he will not still understand even though the teacher explains it. Then, when the first KPMM test was submitted to students, they reported that question narrative was the most challenging. Students report that questions asked by researchers are different in a way significant level of difficulty from the usual questions done by students.

They then interviewed math teacher class VIII 3 SMPN 17 Pekanbaru. It is known that the conventional learning model uses a lecture technique that the teacher always carries out. Practice questions and examples questions from book print with question standards provided to help students study more far away. The teacher once gave question problems of a contextual nature to

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improve students' KPMM, but many experienced difficulties finishing it, so the teacher returned with routine questions. In addition, it is also carried out observation to material learning System Linear Equations of Two Variables (SPLDV) in class VIII 3 SMPN 17 Pekanbaru in the odd semester year 2022/2023 academic year. During the learning process, observation was done to identify areas needing repair. Based on the observation of the results, the learning process in mathematics class VIII 3 is under standards, and low Student KPMM results.

Consequently, the design of a teacher-centered curriculum inhibits active students' participation. Permendikbud Number 22 of 2016 does not follow well in creating and implementing learning strategies. Teachers who want to increase KPMM must be proficient in controlling the learning process because one factor affecting Student KPMM level is the learning process [9].

Problem-Based Learning (PBL) is an approach to learning that is believed to improve students' KPMM [10]. PBL is learning that begins with overcoming problems that must be completed with fresh [11]. Muis defines learning based on problems as a learning constructivism that allows students to participate in learning and solving problems whose solution has been found or found in everyday life [12]. This was done by Sumartini research, which found that students who use PBL improve KPMM more significantly than students who use conventional learning models. [10]

PBL model is implemented in five stages of learning: (1) orientation of student to problem; (2) organization learning; (3) investigation of individuals and groups; (4) creation and presentation of work or products; and (5) analysis and evaluation of the problem-solving process. Problem [13]. Five phases of implementation of the related PBL model with the KPMM process. Avianti and Yuanita [4], in PBL, students are oriented. Then, they are organized for study by the first KPMM stage, namely, understanding problems and problem-solving planning with differentiated known and doubtful components. Students must gather information and carry out the problem-solving process problems in the PBL stage third, which involves supervision and investigation of individuals and groups. This aligns with the second KPMM indication: implementing a resolution strategy for the problem. Problem-solving process problems were made and served in PBL stages four and five, which were continued with stage analysis and evaluation by indicator end problem-solving ability, namely the ability to understand the data obtained. In phase one, this student sought to conclude from the results of his group's discussion by finishing problems and presenting them, actively answering when other groups were present, making conclusions from problem-solving, and summarizing the learning process.

Based on an interview with the teacher, one of the material lessons in Mathematics class VIII that became a constraint is Statistics. This is supported by Yusuf et al. [14], who state that students experience significant difficulty understanding content statistics when solving problems — good problem narrative and diagram problems. In line with the draft of PBL learning, statistics is one of the most relevant sources in everyday life. PBL helps students increase their problem-solving ability when they enter contextual problems in the learning process. Problem contextual given to student For solved.

Study This uses an integrated PBL learning model with short scientific principles and the use of LKPD in every meeting to improve students' KPMM, specifically in material statistics. PBL can help students in class VIII 3 of State Middle School 17 Pekanbaru learn statistics more

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effectively and achieve higher KPMM. With active participation in real-world situations, PBL allows students to analyze all potential causes, consequences, and solutions to increase their ability to think critically and solve problems.

METHODS

The research was conducted in class VIII 3 of SMP Negeri 17 Pekanbaru in the even semester of the 2022/2023 academic year. In the even semester of the 2022/2023 academic year, from May 23 to June 9, 2023. Collaborative classroom action research (CAR) is a type of research conducted by mathematics teachers and researchers together to apply their findings. As expressed by Suyanto [14], CAR is a type of reflective study that discusses real-world problems educators face daily by implementing specific steps to improve the learning process in the classroom more professionally. This study has two cycles, each consisting of two meetings and one KPMM test. There are four steps in conducting classroom action research: (1) preparation, (2) implementing strategies, (3) observing, and (4) reflection [15].

Forty-one students in class VIII 3 of SMP Negeri 17 Pekanbaru—19 male students and 22 female students with varying ability levels—were the study subjects in the even semester of the 2022/2023 academic year. Various learning tools were used in this study, including worksheets. Observation of teacher and student activities, evaluation of KPMM cycles I and II, worksheets Work students (LKPD), plan implementation learning (RPP), and syllabus. LKPD is compiled based on material that has been developed in the RPP. The purpose of making LKPD is to help students find scientific concepts or materials so that their understanding of the concept will be remembered longer and help them apply the concepts found in everyday life. LKPD is compiled For four meetings with adapt indicators in KPMM and the Problem-Based Learning (PBL) model. LKPD is compiled based on the material that has been developed in the RPP with the following division: LKPD-1 contains material on single data distribution analysis, LKPD-2 contains material on single data centralization measures (mean value), LKPD-3 contains material on single data centralization measures (median and mode), and LKPD-4 contains material on single data distribution measures (range, quartiles, quartile range).

Devices such as sheet observation activities from teachers and students were also used for qualitative data. Teacher and student activity data were analyzed using descriptive analytical techniques based on sheet observation during the learning process. According to Miles and Huberman [16], the steps of qualitative data analysis are data reduction, data presentation, and data retrieval. Conclusion. The learning process has seen improvement if good activity between teacher and students, especially from cycles I to II. In addition, the activities carried out during the learning process and stages of the scheduled PBL model implementation are also aligned.

The rule lowered the KPMM assessment from Ali Hamzah [8] to measure achievement KPMM indicators for each student in the study. Recommendations are shown in Table 2 below:

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Table 2. Guidelines Scoring Ability Solution Problem Mathematical.

KPMM Indicator	Score	Information
Understand Problem	0	Not writing The same as what is known and asked
	1	Write one of the lines between what is known and what is asked.
	2	Make known and ask , but not enough accurately.
	3	Accurately write every piece of information.
Plan Solution Problem	0	Not writing plan settlement problem The same very
	1	Plan settlement problems by creating an incorrect mathematical model.
	2	Plan problems solving to create a suitable mathematical model
Carry out Plan Solution Problem	0	Not writing a solution the problem
	1	Please write down the solution, but the solution is wrong or only part of the solution.
	2	Please write down half or part big solution with the Correct
	3	Please write down the solution with the correct and complete
Interpreting the Results Obtained	0	There is no conclusion.
	1	Analysis of the result with interesting, less conclusion appropriate.
	2	Analysis of the right results and conclusions.

Source: [8]

Information results in the KPMM test of students in the cycle were used To know initial KPMM level students and KPMM in cycles I and II. evaluated quantitatively. The analysis conducted consists of the following:

1. Analysis achievement indicator
2. KPMM analysis in general classical

Analysis KPMM participant qualifications educate according to Table 3 below:

Table 3 Criteria Ability Solution Problem Mathematical Learners

Value Interval	Criteria
$85 < NA \leq 100$	Very good
$70 < NA \leq 85$	Good
$55 < NA \leq 70$	Enough
$40 < NA \leq 55$	Not enough
$0 < NA \leq 40$	Very less

Source: [8]

Student KPMM increased If more students in cycles I and II received marks with excellent and very good criteria, whereas in cycles I and II, more students got mark criteria less and significantly less.

Every cycle is said to succeed if the learning process and student KPMM increase the consequence implementation of the PBL model. If the activities of teachers and students increase along with the learning process, the learning process will improve from cycle I to cycle II. In addition, the activities carried out during the learning process and the scheduled stages of

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implementing the PBL model are also included. Then, if more and more students are included in the good or very good group, while fewer and fewer students get grades that meet the standards of less and very low, the KPMM is said to have increased. If the KPMM value increases classically, then the KPMM is also considered to have increased.

RESULTS AND DISCUSSION

The results of this study include students' abilities in solving mathematical problems and teacher and student activity sheets used during the learning process.

Analysis of Teacher and Student Activity Data

Based on the observations on the observation sheet of teacher and student activities in cycle I, preliminary activities have not been implemented well. At the beginning of the implementation of cycle I actions when forming class groups, it became noisy because students were still looking for a Friend, a group, and a seating position, so the teacher must arrange the position of each group that students will occupy. However, along with implementing the cycle I action, students were more orderly even though some were still noisy. At the beginning of cycle I, students are still seen as not being active enough during the learning process, but at the end of the implementation action cycle I, students have started to be active in the learning process. In cycle II, the teacher has corrected the deficiencies based on reflection in cycle I. In cycle II, forming groups no longer takes long until all students sit in their respective groups. In cycle II, the number of students who responded with apperception and motivation increased significantly. From the results of observations of teacher and student activities on the cycle II observation sheet, the implementation of learning has been carried out according to the plan. Students are increasingly seen to be active during the learning process. The learning process in core activities is getting better with each meeting.

In the orientation phase of students on the problems of cycle I, students tend to be passive in responding and do not understand the problems given at the beginning of the implementation of cycle I actions. Students are still quiet if they do not understand and do not ask the teacher, so the teacher asks first what the difficulties are for students. In line with the implementation of the cycle I action, several students began to respond and began to understand the problems given. In cycle II, the number of students who asked questions increased, and students were no longer embarrassed or afraid to ask. In cycle II, almost all students could understand the problems given, and students could identify problems and actively discuss them in groups.

In the phase of organizing students to learn in cycle I, at the beginning of the implementation of cycle I actions, students still had difficulty identifying the problems given. In cycle I, students were also not used to modeling problems well. In cycle II, students started to write down what was known and asked nicely, although some only copied their friends' answers. In cycle II, students also started to become accustomed to modeling problems so that they could do it in stages.

In the phase of guiding individual and group investigations in cycle I, at the beginning of the implementation of cycle I actions, the teacher did not encourage students enough to collect information related to the problems to be solved. Some students still work individually in groups

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and even see the answers from other groups. Participants need to be repeatedly reminded to gather information from the print book. In line with the implementation action cycle, I cooperate with the group more walk with good. At the end of the implementation action cycle, the students and I are already used to LKPD work. In cycle II, the teacher encourages students to collect information as well as possible and encourages each student to work together in groups. Activity This can seen in Figure 1. The teacher also actively motivates through Mark's addition to the collaborative group . The cooperation of each group in working on LKPD looks better. Students carry out the learning process facilitated by the teacher well. Students actively express their opinions in group discussions.

Figure 1. Guiding phase investigation individual

In the phase of developing and presenting the results of cycle I work, at the start of implementing cycle I actions, students only read out the results of their discussions during the presentation. Even though No understood what he read (Figure 2), this happened because students were still shy and lacked confidence in presenting the results of their discussions in front of the class. Also, they followed in a way that was active in work on LKPD, making it difficult to do a presentation. In line with the implementation of cycle I actions, students are better at presenting and explaining the results of their group discussions. At the end of the implementation of cycle I actions, students who responded to the results of other groups' discussions that were presented began to increase. In cycle II, students also got better at presenting the results of their discussions and could explain the results well, not just read the discussion report. Other students paid attention to the discussion, which improved the class discussion.

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Figure 2. Phase of developing and presenting the work results

In the phase of analyzing and evaluating the problem-solving process in cycle I, at the start of implementing cycle I actions, students were not too enthusiastic about giving responses and evaluating the answers of the presenting group. In cycle II, analyzing and evaluating the problem-solving process have been running better. Students are enthusiastic in giving responses and evaluating the answers of the presenting group.

The activities of teachers and students in the final activities also improved. At the beginning of implementing the cycle I action, the teacher only delivered the conclusion because of limited time. At the second meeting, the researcher Already involved participants in delivering conclusions. At the beginning of the implementation of the cycle I action, the teacher did not reflect on the learning activities that had been studied. In line with the implementation of the cycle I action, the teacher reflected on some students. In cycle II, the number of students who dared convey conclusions and respond to reflection increased learning.

Based on the activities described in the implementation of cycle I and cycle II actions, it can be seen that there is an increase in student activities to be better during the learning process. The shortcomings in the learning process are getting less along with the implementation of actions in cycles I and II, so the learning process implemented is improving until the end of cycle II. Analysis of learning steps in cycle I and cycle II shows an improvement in the learning process in class VIII $_3$ SMP Negeri 17 Pekanbaru on the primary material of single data statistics in the even semester of the 2022/2023 academic year.

Analysis of Students' Mathematical Solution Problem-Solving Ability

After the PBL approach was applied to the main topic of statistics, the KPMM of class VIII 3 students of SMP Negeri 17 Pekanbaru was studied as follows:

Improvement Analysis on Each Frequency KPMM Qualifications for Participants Educate before and after action:

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Table 4. Improvements on Every Frequency KPMM Qualifications for Participants educate

Value Interval	Amount Participant educate			KPMM Qualifications
	Initial Test	Cycle I	Cycle II	
85.00 – 100	0	4	24	Very good
70.00 – 84.99	3	10	11	Good
55.00 – 69.99	9	8	6	Enough
40.00 – 54.99	14	12	0	Not enough
0 – 39.99	15	7	0	Very less

Based on the data in Table 4, information was obtained that by applying the Problem-Based Learning model, KPMM students at each qualification experience improvement.

1. KPMM analysis in general Classical

Table 5 below shows the average KPMM value of students for every KPMM indication based on the results of Student KPMM test cycles I and II:

Table 5 Average of KPMM Indicators in Cycle I and Cycle II

No	KPMM Indicator	Average KPMM	
		Cycle I	Cycle II
1.	Understand problem	82.11	94.71
2.	Plan problems solving	25	67.68
3.	Carry out plan problems solving	55.28	76.82
4.	Interpret results obtained	48.78	80.48

The data in Table 5 shows that in Cycles I and II, the average KPMM indicator for each student experienced improvement. Indicator understanding problems have the highest KPMM value. Students are more proficient at each cycle in recognizing aspects from known and asked questions. KPMM indicators for making plan settlement problem, still There is a lack in indicator This although capacity students in plan problem increase in every cycle. Disadvantages include the other students who complete problems more quickly than create a problem-solving strategy or write only part. On each cycle, improvement in indications third, namely the implementation of settlement strategy problems. Some problems experienced by students on indicators, among other things, are the use of wrong formulas or errors in operation calculations that cause inaccuracy in data interpretation.

Table 6 below This gives an analysis of the improvement KPMM classical on the topic of single data statistics before and after the PBL model is practiced:

Table 6 Improvement, Average KPMM Value of Participants, Educate in a way Classical.

	Participant KPMM Score educate	
	Cycle First	Cycle Second
The average KPMM Value of Participants who educate	55.97	81.09
Improvement		25.12

Source: Processed Data Researcher, 2023

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Table 7 shows the average value for the beginning problem-solving ability of the mathematical student cycle I, which was 55.97. In cycle II, the average response value for students to question statistics increases as much as 25.12 to 81.09.

Discussion

The discussion is based on analyzing the results of the KPMM test carried out by students using the final cycle test questions and observation data obtained from student and teacher actions during the learning process using observation sheets. Based on the findings of pre-action interviews with teachers and students of class VIII 3 SMPN 17 Pekanbaru, it was concluded that children's KPMM was classified as low. The researcher aims to improve mathematics by applying Problem-Based Learning (PBL). The purpose of implementing PBL is to improve students' KPMM. This is because PBL is a problem-based contextual model that allows students to explore every possible cause impact and solution to problems by being actively involved in real problems so that students can develop critical thinking skills and have the problem-solving ability faced in the real world [17].

The PBL model is increasingly used in learning planning based on data analysis of teacher and student activity. The learning process is also getting better. According to the observation sheets throughout the learning process, most students' involvement in class VIII 3 SMPN 17 Pekanbaru is increasingly active at each problem-solving stage. The learning process was carried out more successfully, thanks to the researcher applying the PBL model. Students are also taught how to develop their knowledge to make learning more memorable and embedded in their minds. This has an impact on students' KPMM.

Based on the information obtained in cycles I and II and their actions, the average KPMM of students for each KPMM indicator increased from cycle I to cycle II for each question number. The average KPMM for the understanding difficulty indicator in cycle I increased to 94.71 in cycle II from 82.11 in cycle I. The average in cycle I for the problem-solving planning indicator was 25, while the average in cycle II increased to 67.68. In cycle II, the average indicator for implementing problem-solving strategies increased from 55.28 in cycle I to 76.82. Cycle I obtained an average of 48.78, while cycle II obtained an average of 80.48 based on markers used To evaluate the data. In a way, the average KPMM of students generally experiences improvement. The average KPMM value of students in cycle II increased to 81.09, compared to the results of test cycle I, which was only 55.97, and of test cycle II, only 41.46. The study's results strengthen and perfect the previous study [4], which shows that PBL improves students' KPMM. For students in cycle II, the average results of the KPMM exam increased to 86.36 compared to the results test in cycle I, which was only 68.61, and the results test initial KPMM was only 39.58 [4].

Researchers emphasize the importance of applying problem-solving techniques while overcoming a problem in the action cycle First. However, many students still remove the stage of solving from the results exam cycle I. Some students only finish the problem and directly give solutions, while others write a plan to settle problems or the same ones. Then, when writing solutions and conclusions, students make errors because they made the wrong calculation the moment they finished the problem. Researchers emphasize the importance of first applying a step of solving while overcoming a problem in the action cycle. However, a prominent student

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Still removes the stage of solving from the results exam cycle I. Some students only finish the problem and directly give a solution, while others write a plan to settle problems or the same one. Then, when writing solutions and conclusions, students make errors because they made the wrong calculation the moment they finished the problem. In addition, each group must collaborate to look for solutions. Involvement and a sense of responsibility help students grow as a result of the learning process, and they also improve the capacity For collaboration in a group.

The increase in KPMM participants is caused by implementing the PBL model, which gives every individual a chance to understand material lessons and improve participation in discussion groups. PBL model in a study to increase participants, KPMM educated a study previously conducted by Sumartini, who concluded that an increase in KPMM participants students who are learning with the PBL model is better than participant students who learn with the learning models [10].

During a study in progress, researchers naturally face several constraints. Obstacles This is not due to a lack of research in the learning process. Allocation time implementation does not follow time planning, resulting in several stages of learning. It is not implemented with good even. It is not implemented the same once. At the time of the activity discussion group, some students worked in a way that individuals and participants were not yet used to solving problems and PBL. Shortcomings in the meeting previously always endeavored to be fixed at the next meeting. Researchers recommend that the creation of planned activity learning is customized with the teacher's ability to manage time and the ability of students to work on the LKPD, which will given.

Based on the findings of students' KPMM and teacher and student behavior studies, it can be concluded that the proposed action hypothesis is correct. Therefore, in the 2022/2023 academic year, implementing Problem-Based Learning can improve the learning process and the abilities of class VIII 3 students of SMPN 17 Pekanbaru on the primary topic of single data statistics in solving mathematical problems.

CONCLUSION

By using Problem-Based Learning in introductory statistics class, students of class VIII $_3$ SMP Negeri 17 Pekanbaru can accelerate the learning process and improve quantitative problem-solving skills in the even semester of the 2022/2023 academic year. Based on research findings, to implement the PBL model effectively, teachers must be able to supervise their students, always remind them of the importance of problem-solving steps, actively help their students, and inspire them to take the necessary actions—modification of the teacher-centered learning model to transform it into a student-centered learning model. Furthermore, when creating LKPD or student worksheets so that LKPD appears attractive and not dull, teachers should utilize creative and different designs. To inspire children to solve difficulties, the challenges generated must also be exciting and relevant to their lives.

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