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Improving learning activities and mathematical reasoning skills for class x students applying problem-based learning

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ABSTRACT

Mathematical reasoning abilities and learning activities of MAN 2 Kota Padang students are still low. Several aspects are believed to be the cause of the low reasoning ability, one of which is the monotonous learning model. The purpose of this study was to improve the activity and mathematical reasoning abilities of class X students through a problem-based learning model using the Class Action Research (CAR) method. The research subjects were students of class X IPA 9 MAN 2 Kota Padang, totaling 36 people. The data in this study were collected through student activity observation sheets, mathematical reasoning ability tests carried out at the end of the cycle, practice questions, field notes, videotaping and interviews. The data analysis technique used is descriptive analysis. The results showed that the Problem-Based Learning model could increase student activity but could not significantly improve students' mathematical reasoning abilities. The completeness of the mathematical reasoning ability test results obtained by students at the end of the study only reached 8%, far below the research target of 50%.

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Introduction

Mathematics learning is a basic science that forms the basis for the development of science and technology (Samura, Juandi, and Darhim 2020), especially the mode of scientific thinking in solving problems (Noviantii, Yuanita, and Maimunah 2020). This is reflected in the objectives of learning mathematics in schools including training ways of thinking and reasoning in drawing conclusions (Susilowati 2018), developing problem-solving skills, and developing the ability to convey information or communicate ideas through oral, written, drawing, graphic, map, diagrammatic, etc (Kasturi, Ma'rufi, and Nurdin 2022 ; Mikrayanti 2021). This means that if mathematics learning in schools is successfully implemented and achieves its goals, it will form students who have good mathematical thinking skills, students who are able to describe problems and generate solutions at once (Santoso 2018; Ali, Setiawan, and Taryudi 2022).

Reasoning is the foundation of learning mathematics because of the basic role that is contained in a person's thought process (Santika et al. 2020 ; Nurfitriyanti, Rita Kusumawardani, and Lestari 2020). Reasoning ability in mathematics is an ability to use rules, properties or mathematical logic to get a correct conclusion (Noviantii et al. 2020 ; Eviyanti et al. 2017 ; Simamora, Rotua Sidabutar, and Surya 2017). With mathematical reasoning, students can make conjectures and then compile evidence and manipulate mathematical problems and draw conclusions correctly and precisely (Sumartini 2015). Mathematical reasoning can also develop and be developed using problem-based learning methods. Reasoning in the

problem-based learning process, especially in mathematics, becomes an interesting research study and is different from reasoning in different cases.

Mathematical reasoning ability in general is still not satisfactory. This can be seen in the average daily test results in class X MAN 2 Kota Padang (XA1 to XA9 as many as 324 students) (UH 1), 59.61% (UH 2) and 69.45% (UH 3). The material studied is about absolute value equations and inequalities (UH 1), rational and irrational equations and inequalities (UH 2), and the three-variable linear inequality system (UH 3).

Student activity in the learning process is also low because students tend to be passive and do not want to ask questions when in fact they do not fully understand the material (Anwar et al. 2022). This results in a learning atmosphere that is not conducive because students are reluctant to be actively involved in the learning process and make the learning process only teacher-centered (Hidayat et al. 2021). To overcome this, it is necessary to improve all aspects, especially in the learning model carried out in the classroom (Noviantii et al. 2020).

One of the lessons that are thought to be able to improve students' mathematical reasoning abilities is problem-based learning based on research in a journal that reviews most of the topics about mathematical approach on problem solving and result that affected from the approach that used on the problem solving using problem solving method as the primary model of problem solving (Rezki Afinadhita et al. 2022). Problem-based learning is learning 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 learning materials also the Impact of the project based learning model In students learning outcome that statistically Improve based on relevant research. (Maryati 2018 ; Darwati 2021; Andrianis, Anwar, and Zulwisli 2018 ; Anwar and Puspita 2018). The characteristics of problem-based learning are (1) making problems as starting points in learning, (2) problems raised are problems that exist in the real world that require multiple perspectives so that they challenge students' knowledge, attitudes and competencies which then require identification of learning needs. and new areas of learning (Andrianis et al. 2018), and (3) PBL involves evaluating and reviewing student experiences and learning processes (Darwati 2021 ; Akbar 2019 ; Siregar 2019). Therefore, this study was designed to improve learning activities and mathematical reasoning skills by applying Problem-Based Learning to the tenth graders of MAN 2 Kota Padang.

Method

The type of research conducted is Classroom Action Research (CAR). CAR is research conducted by the teacher in the classroom or where he teaches that focuses on improving the process and practical learning (Kurama, Tampang, and Sanger 2022 ; Natalia 2017). This research was carried out in two cycles consisting of four stages, namely planning, implementation, observation and reflection (Susilowati 2018). The subjects of this study were students of class X IPA 9 MAN 2 Kota Padang City with a total of 36 students. The scope of this research is limited to mathematics. The data collection used in this study used the results of learning tests, practice questions, observation sheets, field notes, videotaping and interviews. While the data analyzed in this study were observational data on student learning activities, data on practice questions, field notes, videotaping, interview results and data on students' mathematical reasoning ability test results.

Results and Discussions

Cycle I

The activities in the first cycle began with planning which was carried out in 4 meetings with an allocation of 2x45 minutes in accordance with the Learning Implementation Plan (RPP). Learning is carried out in groups, so before entering the first meeting, students are divided into 8 groups, each group consisting of 4 to 5 people. At the implementation stage, it is carried out through the implementation of a problem-based learning model by collecting problems as well as facts and strategies to solve these problems. During the learning stage in the first cycle, observations were made on student learning activities carried out by the observer. The observed student learning activities were asking either the teacher or friends, reading the Student Worksheet (LKS), answering or responding to the teacher's questions, being actively involved in groups and doing the exercises independently. The results of observations on student activities during learning take place in cycle I can be seen in table 1.

Table 1. Results of Observation of Student Activities in Cycle I

Activity	The meeting								Average	Category
	1		2		3		4			
	f	%	f	%	f	%	f	%	%	
Ask	5	14	8	22	6	16	10	28	20	Low
Reading worksheets	18	50	20	56	25	66	25	66	60	Currently
Answering or responding to questions	9	25	10	28	12	33	13	36	31	Low
Actively involved in the discussion	18	50	19	53	19	53	20	56	52	Currently
Doing tasks independently	1	3	2	6	6	16	8	22	12	Very low
Attendees		36		36		36		36		

Based on the data from table 1, it is shown again in a bar chart with the intention of seeing an increase in each item (indicator) of student activity that occurred in cycle I. It can be seen in Figure 1, that the activity of reading LKS has increased in the medium category, the activity is actively involved in the discussion, answering or responding to questions and doing tasks independently increased but still in very low and moderate categories. For asking activity decreased from meeting 2 to meeting 3, namely from 22% to 16%.

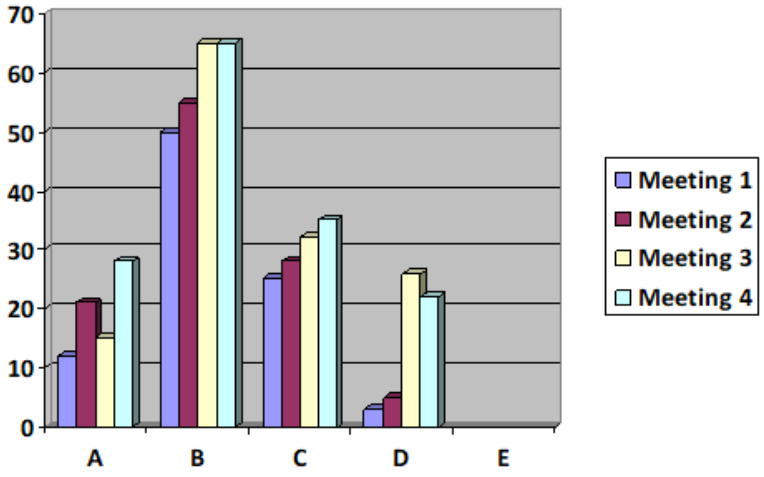

Figure 1. Cycle I student activity progress

Based on Figure 1, the activity of asking the teacher or friends is carried out by students when working on worksheets and during discussions and during presentations. The activity of reading LKS is carried out by students during group discussions. Activities to answer or respond to questions are carried out during discussions and presentations. The activity of being actively involved in the discussion was carried out by students when working on the LKS in groups. Discussions are carried out by students when solving problems in the LKS. This activity has increased from meeting 1 to meeting 4. The activity of doing assignments independently is carried out by students when doing independent assignments. While the results of the students' mathematical reasoning ability test for the first cycle can be explained in table 2.

Table 2. Mastery of Mathematical Reasoning Learning Outcomes in Cycle 1

Completeness	Amount	%
Students who achieve mastery learning	4	11%
Students who have not achieved complete learning	32	89%

Based on data from table 2, it can be seen that the number of students who completed learning was only 4 people (11%) while the number of students who did not complete learning was 32 people (89%). This result is still far from what is expected, namely 50% of students who complete. Meanwhile, the results of the processing of cycle I learning activities in detail are presented in table 3.

Table 3. Learning Activity Score Based on Learning Observation I

No	Indicator	Score
1	Presenting Math statements with pictures	75%
2	Applying conjectures	3%
3	Draw a conclusion	25%
4	Give reasons for solutions	28%
5	Checking the validity of an argument	11%
	Average score	**28.4%**

Guidelines for student activity criteria in learning are as follows (Sizi, Bare, and Galis 2021):

Table 4. Guidelines for student activity criteria

Achievements	Criteria
75% - 100%	High
50%- 74,9%	Currently
25%- 49.55%	Low
0 - 24.99%	Very low

Based on the results of the observation of learning activities above, it is known that only 1 indicator meets the minimum criteria of an average of 28.4% with very low criteria. The indicator is the activity "Presenting Mathematics statements with pictures". This can be seen when discussing students who have not been able to submit conjectures or conjectures in a very low indicator of 3%. Therefore, indicators that have not reached an average of at least 75% will then be used as reflection material and corrected in cycle II.

At the end of the lesson, the reflection stage is carried out by collecting various obstacles and problems experienced during cycle 1, the alleged causes of the obstacles and the solutions chosen. Reflection is carried out with the observer to review what has been done and what has happened during the learning process. The results of reflection and discussion with observers on research data in cycle 1 are shown in table 5.

Table 5. Cycle 1 Reflection Results

Component	Obstacles encountered	Alleged cause	Selected solution
PBL model implementation	▪ Students do not really understand the PBL steps. ▪ Students often ask the teacher to explain the material during the discussion before reading the LKS well	▪ Students are not used to reading worksheets and finding their own formulas	▪ Each student will be given one worksheet. ▪ The researcher will pay attention and guide the student
Students' mathematical reasoning ability	▪ The number of students who complete is very low at 11% ▪ Students' ability to solve mathematical reasoning problems has not developed yet	▪ There are still many students who have not been involved in learning ▪ Students are accustomed to asking the teacher for explanations ▪ Students are not familiar with reasoning questions	▪ Researchers will pay attention and guide these students. ▪ Each student is given one LKS ▪ Students will be given examples of reasoning questions other than those in the independent assignment
Student learning activities	▪ Students don't want to ask questions during presentations ▪ Not all students have the	▪ Students feel they have understood the material presented ▪ Only one worksheet	▪ Students who ask questions during the presentation will be rewarded

	initiative to read and understand LKS ▪ There are still many students who have not been actively involved in the discussion ▪ Most students work together in completing assignments independently	in each group ▪ Students are familiar with the lecture model ▪ There are groups where all members are not communicative ▪ Students are accustomed to working together in doing exercises	▪ Each student will be given one LKS ▪ Changing groups ▪ Researchers will supervise students more in doing independent assignments
Activities in PBL	▪ Students are not used to writing things that are known from the problem. ▪ There are still many students who have not been able to establish problem-solving strategies and apply them, especially during independent assignments and UH	▪ Students forget to write down things that are known from the questions ▪ Students do not understand the problem well	▪ Researchers explain things that are still not understood by students and discuss questions that cannot be solved by students

Cycle II

Researchers explain things that are still not understood by students and discuss questions that cannot be solved by students. From the results of the reflections carried out, the researchers together with the observers made a decision to continue the research in cycle II by taking corrective actions, namely:

1. Researchers change discussion group members
2. The researcher gives one worksheet for each student
3. Researchers will supervise students more when doing independent assignments.
4. The researcher will give examples of reasoning questions other than those in the independent assignment.

At the planning stage, it was carried out almost the same as the first cycle, which included preparing lesson plans and worksheets, preparing test questions, preparing observation sheets and forming new groups. At the implementation stage, students solve problems in the LKS by finding problems, collecting facts, developing strategies for problem solving and implementing the chosen strategies. While at the observation stage, the observer made observations during the learning process for 3 meetings which can be seen in table 6.

The discussion plan that will be carried out in cycle II is focused on how the student is able to solve a problem from the case study given by the researcher, where before that the researcher will give examples of several ways in how to find or discuss a solution first and then throw it back to the students. with different problem topics but still in the context of the material at the learning process.

The activities carried out by students in the second cycle were good and the percentage increased from the first cycle, except for the activity of doing assignments independently which was categorized as low. The activity of asking questions and doing assignments independently decreased from the seventh meeting to the eighth meeting, namely from 65% to 29% and from 39% to 29%. This is influenced by the attendance of students at the seventh meeting which is a little bit, namely 23 people. The results of the students' mathematical reasoning ability test for the second cycle can be seen in table 7.

Table 6. Results of Observation of Student Activities in Cycle II

Activity	The meeting			Average	Category
	6	7	8		

	F	%	f	%	F	%	%	
Ask	15	42	15	65	10	29	45	Currently
Reading worksheets	36	100	23	100	35	100	100	Very high
Answering or responding to questions	13	36	13	57	20	57	50	Currently
Actively involved in the discussion	20	56	20	87	32	91	78	High
Doing tasks independently	8	22	9	39	10	29	30	Low
Attendees		36		23		35		

Table 7. Mastery of Mathematical Reasoning Learning Outcomes in Cycle II

Completeness	Total	%
Students who achieve mastery learning	4	11%
Students who have not achieved complete learning	32	89%

From the table, it can be seen that only 3 students (8%) completed and 33 students (92%). This result is still far from what was expected. While the results of the processing of cycle I learning activities in detail are presented in table 8.

Table 8. Learning Activity Score Based on Learning Observation II

No	Indicator	Score
1	Presenting Math statements with pictures	73%
2	Applying conjectures	5%
3	Draw a conclusion	50%
4	Give reasons for solutions	28%
5	Checking the validity of an argument	28%
	Average score	36.8%

Based on table 8, the average score of student learning activities based on learning observation II is slightly higher than learning observation I. However, this score is still far from the expected results. Then at the reflection stage of the second cycle, the researchers and observers found several important things which were then taken into consideration for carrying out the next cycle. From the analysis of learning activity data and the results of mathematical reasoning abilities, the following things were found: 1) Two activities that are Learning Activity carried out by students have increased even though they are still in the low and medium categories which can be seen in the previous data, namely the first with an average score of 28.4% and in the second activity with an average score of 36.8%. which can be said to increase by 8.4%, but if you refer to the grouping table, it means that the average score below 75% is still low and moderate. Two that are Mastery of Mathematical Reasoning activities increased with high and very high categories based on the table 2 and table 7 that showed the result of the score are 89% and based on the observation table that means above 75 is classified as high and very high; 2) Students' mathematical reasoning ability decreased with a very low percentage of completeness, namely 11% in the first cycle and 8% in the second cycle. Compared to the success indicator of this research, which is 50%, it is still very far.

Based on the reflection analysis in cycle II, students have not achieved the expected results, so this research must be continued to the next cycle, but due to time constraints, the researcher only reports until cycle II.

The researcher concluded from the results of interviews that students had been used to the lecture model where the teacher explained everything, and students only listened, then continued with sample questions and exercises. This kind of learning model that they often encounter so far, maybe even starting from elementary school, so that when the PBL model is applied, some students need time to get used to this model.

Another reason is that students are not familiar with reasoning questions or the questions that the answer require an analysis or description about the problem and the solution that they offered with the students' own thinking and use of sentences and also with a logical reason of the answers Itself . Students are rarely given questions that require their reasoning to solve. Questions like this have never been found during exams, either in semester exams or final exams, in Olympic questions or in competition questions that are not followed by all students. It takes enough time for students to get used to the questions of reasoning and get used to the varied learning models. Therefore, this research must be continued until it is successful.

It can be explained that by using the project based learning model in this subject, it can be said to be able to provoke the literacy level of students as evidenced by data from 3 cycles which explains that the average score level of students in each cycle always increases slowly but surely so that the use of this model Based on data, theory and observations from researchers, it can be said that it is quite valid and can be used for future learning which is expected to be better in improving students' literacy skills in solving problems in the scope of the material provided.

In addition to being trained in improving problem-solving skills, the researchers also demonstrated in advance the procedures and stages of each cycle for students to work on later so that students were able to adapt what was exemplified to other case studies but still related to the material taught at the meeting. so that students' skills in problem solving and literacy can be trained and developed through the use of this project based learning model in the future.

Conclusions

Based on the results of research and discussion, it can be concluded that the Problem-Based Learning model can improve learning outcomes and student activities in class X IPA 9 MAN 2 Kota Padang. These results can be seen from the increase in student learning outcomes in the pre-cycle, cycle I, and cycle II. Although it was found that the increase in learning activities was not too large, the trend or trend from meeting to meeting and from cycle I to cycle II was positive.

It is hoped that the existence of this research can be a consideration for teachers in choosing learning models in improving student learning outcomes. Teachers need to make efforts to maintain student learning outcomes in order to achieve optimal learning outcomes by applying various learning models. Principals need to monitor and grow the impact of Classroom Action Research (CAR) activities, such as materials to assess the progress that has been achieved, so that what is found can be implemented in the implementation of learning in schools. Further researchers in the development of science are expected to be able to use the Problem-Based Learning model as one of the learning models that can be applied in other subjects.

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