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The Effect of the Problem-Based Learning Model on The Numeracy Ability of Grade X Students in Solving AKM Problems on Opportunity Material

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Abstract

This research was conducted on grade X students of a public senior high school in Karangbinangun, Lamongan, Indonesia, on opportunity material by applying Problem-Based Learning (PBL) model. This study aims to determine the effect of the PBL model on students' numeracy ability in solving *Asesmen Kompetensi Minimum* (AKM) problems on opportunity material. This research is quantitative research using a nonequivalent control group design. The sampling technique used in this study was purposive sampling. Data collection techniques in this study used test instruments, whereas the validity, reliability, differentiating power, and difficulty index have been explained. The data analysis techniques used independent sample *t*-test and *N*-gain test. The results showed that applying the PBL model could improve the numeracy ability of students in solving AKM problems on opportunity material. This is evidenced by the difference in the average post-test score obtained by students in the experimental class (88) and in the control class (84). Based on the calculation of the average pretest and post-test in both classes, the percentage of numeracy ability of students in the experimental class was 55.62%, while the percentage of numeracy ability of students in the control class was 51.73%. The calculation of the independent sample *t*-test also shows significance in the value of sig. (2-tailed) less than 0.05 (0.000 < 0.05). Therefore, the PBL model affects students' numeracy abilities.

Keywords: *Asesmen kompetensi minumum* (AKM), numeracy ability, problem-based learning (PBL)

INTRODUCTION

Education is an orderly and conscious effort to create a thriving learning and experiential environment with the aim that students effectively cultivate their ability to have the strength, wisdom, character, and abilities that others and society need (Abd Rahman et al., 2022). Following Law Number 20 of 2003 concerning the National Education System, it is important to determine the goal of national education is to cultivate students' abilities to become individuals who fear God Almighty, have a noble character, are educated, skilled, imaginative, independent, become a democratic-based and reliable society (Sofiah, 2015). One of the government's efforts to achieve national education goals is to design an independent curriculum.

The Merdeka Curriculum combines intracurricular learning and various content to give students sufficient time to investigate concepts and improve their skills (Khoirurrijal et al., 2022). This curriculum focuses on essential materials to provide students with enough time to understand concepts and improve competencies. Essential materials are important materials or subjects that must be mastered and understood by students, and sustainable materials exist at all levels of grade or phase of education (Ministry of Education and Culture, 2021a). Teachers can choose various teaching materials so that learning can be adjusted to the interests and needs of students. One of the reasons for the establishment of an independent curriculum by Minister of Education and Culture is that in 2019, the Program for International Student Assessment (PISA) test results showed that the assessment results of Indonesian students only ranked sixth in the bottom, in terms of reading and mathematics literacy, Indonesia ranked 74th out of 79 countries (Sari, 2019).

These results show that Indonesia is still far behind other countries in terms of education development. Therefore, in 2021, the National Assessment became a new policy of the Ministry of Education and Culture, replacing the National Examination (Rohim et al., 2021). Assessment is evidence of achieving learning objectives during the learning process (Anggraena et al., 2022). National assessment aims to improve the education system and monitor and evaluate it. The National Assessment consists of three parts: *Asesmen Kompetensi Minimum* (AKM), character survey, and learning environment survey.

The assessment of basic skills needed by each student to develop their abilities and contribute positively to society is known as AKM (Ministry of Education and Culture, 2021b). The cognitive abilities of students measured in AKM are reading ability and numeracy ability (Novianti, 2021). The ability to use numbers, data, and mathematical symbols to solve real-world problems and the knowledge and skills to do so is called numeracy (Anderha & Maskar, 2021). The content used in numeration AKM adapted from PISA content domains are algebra, measurement and geometry, data and uncertainty, and numbers (Rohim et al., 2021).

Researchers are interested in using opportunity material that falls into data and uncertainty because of its close relationship with everyday life, such as weather forecasts, economic models, scientific predictions, and others. This is to the concept of numeracy, which is having the ability to apply the concept of numbers, perform arithmetic operations, and explain the information we encounter in everyday life (Winata, Widiyanti, & Cacik, 2021). Numeracy concepts in daily life include measuring time and distance when traveling, weather forecasting, and password preparation. Facts on the ground do not correspond to reality, especially since the ability students' numeracy is still low, even though numeracy ability is very important for students in school life, life outside of school, and even for durability in the eyes of the public (Nasoha et al., 2022).

Based on the results of an interview with a mathematics teacher at a public senior high school in Karangbinangun, students' ability to answer numeracy-based questions is limited to those in the student handbook. The numeracy ability of new students comes to the calculation process, and they have not been able to model authentic problems into mathematical models, let alone solve them. This can happen if teachers often use direct learning models (Kurnila et al., 2022).

Teachers must be able to solve problems in the learning process by choosing the right learning model. One alternative learning innovation that teachers can apply is the PBL Model. The PBL model is a learning model that can help students process the abilities or capacities they need in the era of globalization and ongoing changes. When students face concrete problems, they are trained to solve problems and learn new things from problem solving (Handayani, 2017).

From the description above, the researcher is interested in conducting research about the effect of the PBL model on the numeration ability of class X students in solving AKM problems on opportunity material.

METHODS

The type of research used in this study is quantitative research using experimental methods. The research design used in this study is a *quasi experimental* design with the type of *nonequivalent control group design.* This research was conducted at a public senior high school in Karangbinangun, Lamongan, Indonesia. The implementation time was in semester 2 of the 2022/2023 academic year.

The sampling technique in this study used purposive sampling. The selected sample was 32 students from class X3 as an experimental class and 32 students from class X4 as a control class. The experimental class was given treatment using the PBL model, while the control class was given treatment using a conventional learning model.

The data collection techniques used in this study were tests and interviews. The tests conducted in this study consisted of a pretest that aimed to assess initial numeracy ability and a post-test that aimed to assess final numeracy ability. The instrument analysis technique used validity tests, reliability tests, differentiating power tests, and difficulty index tests. Data analysis techniques in this study used normality tests, homogeneity tests, hypothesis tests, and *N*-Gain tests.

RESULTS AND DISCUSSION

Description of Research Activities

The study was conducted four times in the experimental class and four meetings in the control class. Each meeting lasts 2 x 45 minutes in experimental and control classes. The first meeting gave pretest, the second and third meetings gave treatment and learning materials were opportunities, while the fourth meeting gave post-test. A pretest was given to determine the student's initial numeracy ability before treatment. The experimental class was given treatment using the PBL model, while the control class was given treatment using a conventional learning model. A post-test was given to determine the student's final numeracy ability after treatment.

Instrument Analysis Results

The instrument is first carried out using expert validity, which is intended to measure the level of validity of the research instrument to maximize the research process so that the research instrument can measure what will be measured by the set target. Researchers conducted an expert validity test with the help of a lecturer in mathematics education and a mathematics teacher. The instruments validated in this study are pretest-post-test, learning objectives flow, teaching module, and student worksheet.

Before use, the test instrument is first tested in a class one level higher than the sample taken, namely class XI. Table 1, 2, 3, and 4 are the results of the test instruments analysis.

Table 1. Test Validity Test

Pretest		
Question Point	Pearson Correlation	Sig.(2-tailed)
1	0.614	0.000
2	0.725	0.000
3	0.718	0.000
4	0.837	0.000
5	0.635	0.000
Post-test		
Question Point	Pearson Correlation	Sig.(2-tailed)
1	0.774	0.000
2	0.804	0.000
3	0.577	0.001
4	0.407	0.021
5	0.606	0.000

If the sig. (2-tailed) value is < 0.05 and the pearson correlation is positive, then the test question item is valid. In Tabel 1, it can be seen that each question item has a sig. (2-tailed) value of less than 0.05 and a positive person correlation value. Thus, all pretest and post-test question items are declared valid and can be used.

Table 2. Reliability Test

	Pretest	
	Cronbach's Alpha	*N* of Items
Reliability Statistics	.747	5
	Post-test	
	Cronbach's Alpha	N of Items
	.645	5

In the reliability test decision-making criteria, if the Cronbach Alpha value > 0.6, the questions to measure the observed variables are reliable. In Table 2, we get a Cronbach

Alpha value greater than 0.6. Thus, all the pretest and post-test items are declared reliable.

Table 3. Differentiating Power Test

Question Point	Pearson Correlation	Criterion
Pretest		
1	0.614	Good
2	0.725	Very good
3	0.718	Very good
4	0.837	Very good
5	0.635	Good
Post-test		
1	0.774	Very good
2	0.804	Very good
3	0.577	Good
4	0.407	Good
5	0.606	Good

There are three pretest questions with distinguishing power criteria with good categories, there are two questions, and very good categories, there are three questions. While the post-test questions with distinguishing power criteria with good categories have three questions, and in the very good category, there are twi questions.

Table 4. Test Difficulty Index

Question Point	Difficulty Index	Criterion
Pretest		
1	0.53	Medium
2	0.52	Medium
3	0.52	Medium
4	0.55	Medium
5	0.55	Medium
Post-test		
1	0.57	Medium
2	0.56	Medium
3	0.55	Medium
4	0.55	Medium
5	0.55	Medium

Based on Table 4, it can be concluded that the pretest and post-test questions have medium difficulty index criteria.

Data Analysis Results

This study's prerequisite analysis tests used are normality and homogeneity tests. The normality test in this study used the Kolmogorov Smirnov Z test. Table 5 shows the result.

Table 5. Normality Test

Class	Sample	Sig.
Pretest Experiment	32	0.088
Post-test Experiment		0.150
Pretest Control		0.200
Post-test Control		0.112

In the normality test decision-making criteria, the data is normally distributed if the significance value > 0.05. Based on Table 5, a significance value of more than 0.05 can be seen, so it can be concluded that the data is normally distributed. Table 6 presents the homogeneity test.

Table 6. Homogeneity Test

	Significance
Based on Mean	0.686

The homogeneity test decision-making criterion states that the variance is said to be homogeneous if the significance value is > 0.05. Based on Table 6, it can be seen that the result of the significance value on the homogeneity test is greater than 0.05 (0.686 > 0.05). So, it can be concluded that the sample used in this study is homogeneous.

After the prerequisite test is met, researchers conduct a hypothesis test to determine whether there is a significant influence of the PBL model on students' numeracy ability. Test the hypothesis in this study using the independent sample *t*-test. The result can be seen in the Table 7.

Table 7. Test the Hypothesis

Equal Variances Assumed	Sig. (2-tailed)
	0.000

In the decision-making criteria for the Independent Sample t-test, namely, if the value of Sig. (2-tailed) < 0.05, then H_o is rejected and H_a is accepted. Table 7 shows the value of Sig. (2- tailed) in this study is less than 0.05 (0.000 < 0.05), so H_o is rejected and H_a is accepted. So, it can be concluded that PBL model significantly influences students' numeracy ability to solve AKM problem opportunity material. Table 8 presents the *N*-Gain.

Table 8. *N*-Gain Test

Class	N-Gain	Criterion
Experiment	0.74	High
Control	0.66	Medium

Based on Table 8, the average *N*-Gain value in the experimental class was 0.74 with the high category, while the average *N*-Gain value in the control class was 0.66 with the medium category. So, it can be concluded that the PBL model affects students' numeracy abilities.

In first meeting, researcher gave pretest for the experimental and the control classes to determine the students' initial numeracy skills. At the second meeting, researchers delivered material on event opportunities and the nature of event opportunities and provided worksheet to students. In the experimental class, students are still less active in following the learning steps properly and in an orderly manner because they are still accustomed to conventional teacher-centered learning. While in the control class, students are familiar with conventional learning models.

At the third meeting, researchers delivered material on the complement and frequency of events and provided worksheet to students. Students have begun to adjust to the PBL model at this meeting. Students understand the PBL model well. In addition, students also begin to actively follow the learning steps appropriately. At the fourth meeting, researchers gave the experimental and the control classes a post-test to find out the students' final numeracy skills. The delivery of material and the completion of mathematical problems on the subject of opportunity can be successfully achieved using the Problem-Based Learning model.

The PBL model is a learning approach that exposes students to a real-world problem to develop problem-solving skills. The syntax of the PBL model is as follows: in the first stage, researchers explain the learning objectives and motivate students to participate actively in the learning process. In the second stage, researchers coordinate students for learning, dividing them into groups. Each group has 5-6 members. At this stage, researchers provide worksheets for students with opportunity material. Third, researchers assist with independent and group investigations. Research helps students collect information from various sources and ask questions to think about problems and information needed to be able to solve problems. In the fourth stage, researchers guide students in preparing the results of discussions to be presented in front of the class. In the fifth stage, researchers help students to evaluate the problem-solving that they have made. At this stage, the researcher helps students to evaluate the problem-solving that they have made.

One of the characteristics of the PBL model is that the questions given to students are real questions, so they can easily understand them and use them in the future (Syamsidah & Suryani, 2018). This is by the concept of AKM problems, namely assessing problem-solving skills or answering questions in the context of the real world or everyday life. AKM questions are used to measure students' cognitive abilities, one of the aspects measured is students' numeracy ability. So, it can be concluded that the PBL model is a relevant for improving students' numeracy skills.

Based on the average score of the post-test, the average score of the experimental class was 88 while the average score of the control class was 84, so the average score of students' numeracy ability in the experimental class was higher than the average score of students' numeracy ability in the control class. This is to the results of research conducted by Masliah & Nirmala (2023) which states that the average numeracy ability of students increases when the learning process uses the PBL model. So, it can be concluded that the factor that affects the high average score of students' numeracy ability in solving AKM problems is applying the PBL model in the learning process.

The results of hypothesis testing obtained data that resulted in a Sig. (2- tailed) value in this study less than 0.05 (0.000 < 0.05), so H_o was rejected and H_a was accepted. That is, the PBL learning model significantly influences students' numeracy ability in solving AKM problem opportunity material. This is to the results of research conducted by Mawarsari & Wardani (2022) which states that the application of the PBL model influences students' numeracy abilities. Based on the explanation above, it can be concluded that the PBL model affects the numeracy ability of grade X students in solving AKM problems for opportunity material.

CONCLUSION

The following conclusions can be drawn from the analysis of research data on the application of the PBL model to the numeracy ability of grade X students in solving AKM problems for opportunity material: 1) The numeracy ability of students in experimental classes whose learning uses the PBL model has an average score of 88. This average is higher than before the PBL model was applied, which was 57. The two averages have a considerable difference of 31; 2) The numeracy ability of students in the control class whose learning uses conventional learning has an average score of 84, with an average initial score of 56; 3) Based on the calculation of the average pretest and post-test in both classes, the percentage of numeracy ability of students in the experimental class was 55.62%, while the percentage of numeracy ability of students in the control class was 51.73%; and 4) Using the PBL model increases students' numeracy ability. This can be seen from the numeracy ability of students taught through the PBL model, which is higher than that of students taught with conventional learning.

Based on the conclusions obtained from the results of the research, the researcher's suggestions are as follows: 1) For students, students are expected to be able to play an active role in the process of learning, which can later help them develop numeracy skills in learning mathematics; 2) For teachers, Innovative learning models should be able to used more creatively by teachers to carry out the learning process. Teachers can also choose or decide on techniques of learning that will later be applied in the process of learning that can further develop the ability student numeracy; and 3) For other researchers, hopefully, this research can be used as a relevant source and develop and consider the limitations and shortcomings of this study.

In this research process, some limitations may affect the results of the research, namely: 1) There are limitations in research time, energy, and research ability; 2) There is a lack of ability to understand the pretest-post-test questions, so that there is a possibility that the results are less accurate; and 3) This study only focuses on the influence of the PBL model on students' numeracy skills, so further research needs to be conducted to examine the influence of other learning models that have yet to be studied on patient satisfaction.

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