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The Effect of Problem-Based Learning Model on Students' Mathematical Problem-Solving Ability of Class VIII at SMP Negeri 35 Medan

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Abstrak

Berdasarkan hasil wawancara dengan salah satu guru matematika SMP Negeri 35 Medan menyatakan bahwa siswa masih kurang dalam menyelesaikan masalah. Tujuan penelitian ini adalah untuk mengetahui apakah model Pembelajaran Berbasis Masalah berpengaruh terhadap kemampuan pemecahan masalah matematis siswa. Penelitian ini merupakan penelitian eksperimen dengan metode eksperimen kuasi dengan menggunakan Pretest-Posttest Control Group Design. Pengujian syarat analisis data ini adalah uji normalitas dan uji homogenitas dimana data berdistribusi normal dan homogen. Untuk menguji hipotesis dalam penelitian ini menggunakan uji Independent Sample t-test. Hasil uji t dari output menunjukkan nilai t hitung sebesar 12,214 dengan nilai signifikansi 0,000. Karena signifikansinya kurang dari 0,05 dan nilai t tabel sebesar 2,002, maka ditolak. Dapat disimpulkan bahwa terdapat pengaruh model Problem Based Learning terhadap kemampuan pemecahan masalah matematis siswa kelas VIII di SMP Negeri 35 Medan.

Kata kunci: *Pembelajaran Berbasis Masalah, Kemampuan Pemecahan Masalah Matematika, Model Pembelajaran Konvensional*

Abstract

Based on the interview results with one of the mathematics teachers at SMP Negeri 35 Medan, it was stated that students still lacked in solving problem. The goal of this study was to establish if the Problem-Based Learning model has affected students' mathematical problem-solving ability. This study was an experimental research with quasi-experimental methods using Pretest-Posttest Control Group Design. Testing the requirements this data analysis is a normality test and homogeneity test where the data is normally distributed and homogen. To test the hypothesis in this study using the independent sample t-test. The t-test results from output shows a calculated t-value of 12.214 with a significance value 0.000. Because the significance is less than 0.05 and t-table value of 2.002, then H_0 is rejected. It

can be concluded that there is an effect of Problem-Based Learning model on students' mathematical problem-solving ability of class VIII at SMP Negeri 35 Medan.

Keywords : *Problem-Based Learning, Mathematics Problem-Solving Ability, Conventional Learning Model*

INTRODUCTION

Education is an important part of the development process of a developing country like Indonesia, where education itself is a conscious effort to develop the potential that exists in a person through teaching. Education is also a form of embodiment of a human culture that is dynamic and full of development. As stated by Sastrawijaya (1991), the purpose of education is everything that includes job readiness, problem-solving skills, constructive use of free time, and so on because the expectations of each student are different.

In the implementation of education itself, there is a learning process and learning outcomes. Real education will not be separated from the process of learning and teaching to acquire knowledge. Teaching is not about trying to impart knowledge but about creating an environmental system that trains students in a way that the learning objective can be successfully achieved. One way to realize the goals of national education is through formal education. In formal education at school, one of the subjects that need more attention in mathematics.

The objectives of learning mathematics in Indonesia, especially at the secondary education level, aim for students to be able to understand mathematical concepts, use patterns as conjectures in solving problems and be able to make generalizations based on existing phenomena or data by using reasoning properties, communicating ideas, having an attitude of appreciating the usefulness of mathematics in life, having attitudes and behaviors that are in accordance with the values in mathematics (Kemendikbud, 2016). However, if in its development mathematics can go as desired, it will create a quality generation in the future, but business does not always go as expected because it is not uncommon for obstacles to arise from students and the immediate environment or even from mathematics itself.

Mathematical problem-solving ability of students in Indonesia is still low. This can be seen from students' learning achievements in mathematics subjects which tend to be lower when compared to other learning materials. This is because some students have the perception that mathematics is difficult to learn, not fun, and difficult to memorize mathematical formulas (Mustangin et al., 2019; Mustangin et al., 2020; Julaeha et al., 2020).

Researcher also found in preliminary investigation in SMP Negeri 35 Medan using observation and diagnostic test that students' problem-solving ability were low. There were students playing games, telling stories with friends, and sleeping while the teacher is teaching. When the initial diagnostic tests (attched) were carried out, students were not able to solve the mathematical problems. Students were not able to identify problems, students were not able to design strategies to solve problems, and transform questions into mathematical language. From 30 students who were given the initial diagnostic test, the students who answered question number 1, mostly answered as done by S8 in Figure 1.

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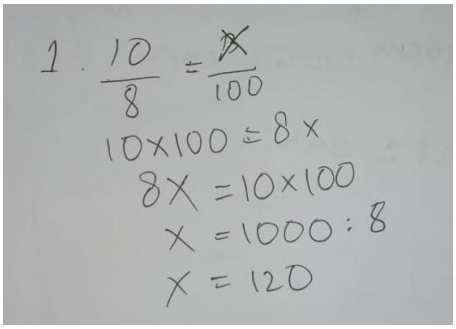

Figure 1 . Diagnostic Test Answersheet of S8

In Figure 1, it can be seen that to solve the problem in question number 1, S8 has not been able to understand the elements that are known or asked in the problem (indicator of problem-solving number 1). So, to take the next step of problem-solving such as planning or strategizing a problem (indicator of problem-solving number 2), students are still failed. As a result, the answer given by S8 are not in accordance with the questions (indicator of problem-solving number 3 and 4). Based on the explanation above, S8 has not fulfilled the indicators of problem-solving ability so it can be said that S8's problem-solving ability is low.

In addition, many students did not answer the assigned tasks at all. When asked why they didn't respond, they said they didn't know how to fix the problem. Based on the results of the diagnostic test, it can be said that the ability to solve average mathematical problems is still relatively low. Of the 30 students examined, 24 students belong to the low category, 4 to the medium category and 2 to the high category. Problem-solving skills are not well acquired, there are still many students who have problems with problem-solving questions, and few students have sufficient problem-solving skills. Therefore, mathematics teachers should use learning models that can improve students' mathematical problem-solving skills.

According to Wahyud & Anugrahen (2017), problem solving is trying to find a way out of a difficult or temporary problem so that the problem does not become a problem. Problem solving is therefore a high skill, because solving requires other skills. Solving mathematic problems is different than solving math problems. According to Hendriana & Utari (2017), the difference between solving a mathematical problem and solving mathematical problems lies in the concepts of problems and questions. Solving mathematicproblems is not necessarily the same as solving mathematic problems. If the solution to the mathematic problem is found immediately, the work is considered normal work and it is not a problem. A mathematical problem is defined as a mathematical problem if its solution cannot be found immediately, but requires several other relevant operationsmathematic. The problem of an individual or a student is not a problem of a person or a student.

The indicators for solving mathematical problems used by researcher in this study are the stages of problem-solving proposed by Polya in Astutiani et al., (2019), namely, understanding the problem, devising a plan, carrying out a plan, and looking back. Because the problem-solving indicators put forward by experts are almost the same, in this study, the researcher chose the stages of problem-solving by Polya because the Polya model provides

an orderly framework for solving complex problems so that it can help students solve problems.

So, it can be defined that problem-solving is an effort to find a way out that is carried out in achieving goals by going through several processes or stages in its completion, also requires readiness, creativity, knowledge, and abilities and their application in everyday life so that the problem is no longer a problem anymore.

From all types of learning, there is an interesting and appropriate learning model that can be taught to students in teaching and learning to improve their mathematical problem-solving skills, which is the Problem-Based Learning (PBL) model. The PBL model is one of the new lessons that involve students in problem solving through sessions that connect the problem with knowledge or concepts that students already know about. According to Sani (2013), problem-based learning can help students develop critical thinking and problem-solving skills, learn professional skills, and become professional students.

Through problem-based learning, students can not only learn concepts related to the problem but students are also able to learn scientific methods to solve the problem. Thus, the application of the PBL model in learning mathematics is possible to encourage students to have their ideas for independent learning, because this model provides opportunities for students to seek their knowledge so that students will gain experience from learning.

In conceptually, Fathurrohman (2015) states that problem-based learning (PBL) is a learning strategy in which students solve a problem through the steps of a scientific process, allowing students to learn information about the problem. And at the same time have problem-solving skills. According to Ngalimuni (2013), a problem-based learning approach focuses on a pedagogical approach where learning is focused on a selected problem so that students not only learn the concepts relevant to the problem but also can solve the problem-solving methods of the problem

The problem chosen as the focus of learning can be solved by students through group work so that students in seeking and exploring knowledge and information as well as their mindset can exchange opinions with other students where students or members in the group can be another source of learning so that diverse ideas and initiatives emerge which are expected to help facilitate students in solving the problem that is the focus of learning. Group work in this Problem-Based Learning model can also encourage students to play an active role in learning. While in conventional learning model, the teacher dominates the class more as a transfer of knowledge, while students are more passive only receiving knowledge conveyed by the teacher, so student activities in learning become passive and the student learning process becomes less meaningful.

From the description above, Problem-Based Learning model is a learning model that emphasizes students' think by gathering various concepts that they have learned from various sources to solve problems and is meant as a first step for investigation and inquiry. The role of the teacher in this learning is as a facilitator to support learning carried out by students. There are 5 phases (stages) that need to be done to implement Problem-Based learning in learning. These phases refer to the practical stages carried out in learning activities with the Problem-Based Learning model as presented in the Table 1.

Table 1. Syntaxes Problem-Based Learning

Phases	Teacher's Activities
Phase 1: Orienting students on the problem	Explains learning objectives, and logistics required, and motivates students to be actively involved in the selected problem-solving activity.
Phase 2: Organizing students to learn	Helping students limit and organize learning tasks related to the problem at hand.
Phase 3: Guiding individual and group investigations	Encourage students to gather appropriate information, carry out experiments, and search for explanations and solutions.
Phase 4: Developing and presenting work	Helping students plan and prepare appropriate work such as reports, videos, and models, and helping them to share their work with their peers..
Phase 5: Analyzing and evaluating the problem-solving process	Helping students reflect on the investigation and processes used during problem-solving.

The relationship between the problem-based learning model and problem-solving skills are two very closely related elements. Both variables focus on the keyword "problem". This view is supported by Barrows' statement (Barrett, 2005), according to which PBL is a learning model based on the principle that problems can be used as a starting point for acquiring or integrating new knowledge.

After teaching the lesson material using the PBL model, the teacher should evaluate the problem-solving process used by the students so that the teacher can learn about the development of the students' mathematical problem-solving skills in the task. Thus, there is a clear connection between the learning model used by the teacher and the students' mathematical problem-solving skills.

Based on the description above, the purpose of this study is to find out how the effect of the Problem-Based Learning (PBL) model on students' mathematical problem-solving abilities of class VIII at SMP Negeri 35 Medan.

METHOD

This type of research is experimental research method. The research used was quasi-experimental consisting of two research group that is, the experimental class is the student who is learning with Problem-Based Learning model and control class are students whose learning is with conventional learning. This study conducted at SMP Negeri 35 Medan where the population is all class VIII. Sampling was carried out using a cluster sampling technique that is, taking samples randomly where before taking the sample test

first normality and homogeneity and where is the variance of normal and homogeneous population.

This was obtained by class VIII 7 as an experimental class with a total of 30 students and class VIII 6 as the control class totaling 30 students. Subject that is taught is Number Patterns. The research design used in this study was the Pretest-Posttest Control Group Design. The researcher chose this design because this design was used more effectively where in this study it involved two sample groups, namely the experimental group that would apply the PBL model of learning and the control group that did not apply the PBL model of learning. The Pretest-Posttest Control Group Design can be seen in Table 2 (Sugiyono: 2013).

Table 2. Research Model Design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Information:
O_1 : Pretest experimental class
O_3 : Control class pretest
X : Treatment with the Problem-Based Learning (PBL) model
O_2 : Posttest experimental class
O_4 : Posttest control class

Data collection techniques used were test and observation. In this study, data collection by means of tests was carried out to measure students' mathematical problem-solving abilities before and after being treated with the PBL model. Observation technique using instruments were carried out by researcher to observe student activities that appeared when they were treated with the PBL model. Observations were also carried out by an observer, namely the mathematics teacher at the school to observe the activities carried out by researcher and students during the learning process.

The instruments used in this study were data instruments for students' mathematical problem-solving abilities, including test questions. The test questions given to students with comparative material are in the form of essays. Before the test is tested, the validation and reliability of each variable are tested first.

The instrument validity test was carried out on class IX students of SMP Negeri 35 Medan. After testing the validity of the instrument by comparing the calculation results using Microsoft Excel with at a significance level of 5% with the provisions then the question item is declared valid. The results obtained were that of the 4 questions tested, all of the four questions were valid and could be used. Based on the results of instrument reliability calculation using Microsoft Excel, a value obtained is 0.942. According to the reliability criteria, it can be concluded that the research instrument has very high reliability.

The data analysis method used in this study consisted of two parts, namely descriptive statistical analysis and inferential statistical analysis. Descriptive statistics, that is,

statistics used to analyze data by describing or describing the information collected, without drawing general conclusions or generalizations (Sugiono, 2013). Inferential statistical analysis is useful in analyzing survey data obtained from a sample so that the results can be applied to individuals as well as populations, samples are obtained that represent the population. Inferential statistics analysis tests carried out include:

1. The normality test of the research data used is Kolmogorov-smirnov using SPSS as test prerequisites for hypothesis testing.
2. Test homogeneity with SPSS through the Descriptive-Statistics test as a prerequisite test for hypothesis testing.
3. Test the hypothesis using SPSS, if the data is normally distributed and homogeneous, then continue with testing the hypothesis using the t-test. However, if the data is not normally distributed then proceed with hypothesis testing using the Mann-Whitney test.

RESULT AND DISCUSSION

Problem solving-ability data was obtained through pretest and posttest. The following is a description of the pretest and posttest in the experimental class and control class in Table 3.

Table 3. Descriptive Statistics of Pretest Scores for Experimental Class and Control Class

Statistics	Class	
	Experimental	Control
The number of students (n)	30	30
Score Maximum (x_{max})	24	22
Score Min (x_{min})	10	10
Total score	459	444
Average score ($\overline{X}$)	15.3	14.8
Median (Me)	14.5	13
Mode (Mo)	10	13
Variance (s^2)	16.84	13.82
Standard Deviation (s)	4.10	3.72

Based on table 3, the average pretest score for the experimental class was 15.3, meaning that most of the experimental class had scores between 15-16 out of the maximum total score of 32. The minimum pretest score for the experimental class was 10 and the maximum score was 24. The standard deviation value was 4.10. with an average score of 15.3, it means that the data is less varied because the standard deviation value is less than the mean. Meanwhile, in the pretest results of the control class, an average score of 14.8 was obtained, meaning that most of the control class had scores between 14-15 out of the total maximum score of 32. The minimum pretest score for the control class was 10 and the maximum score was 22. The standard deviation value was 3.72 with an average score of

14.8, meaning the data is less varied because the standard deviation value is less than the mean.

Based on the average pretest score for the experimental class and control class, the variance and standard deviation in the experimental class, namely 16.84 and 4.10. Meanwhile, the variance and standard deviation in the control class were 13.82 and 3.72. It means that the variance of the experimental class is greater than the control class. This causes the distribution of data in the experimental class to be more heterogeneous than in the control class, meaning that the mathematical problem solving ability scores of students in the experimental class are more varied and spread out relative to the class average, while the mathematical problem solving abilities of students in the control class tend to be clustered.

The following is a description of the pretest and posttest in the experimental class and control class in Table 4.

Table 4. Descriptive Statistics of Posttest Scores for Experimental Class and Control Class

Statistics	Class	
	Experimental	Control
The number of students (n)	30	30
Score Maximum (x_{max})	30	26
Score Min (x_{min})	24	18
Total score	829	651
Average score ($\overline{X}$)	27.63	21.7
Median (Me)	28	22
Mode (Mo)	27	22
Variance (s^2)	2.65	4.42
Standard Deviation (s)	1.63	2.10

Based on Table 4, the average posttest score for the experimental class was 27.63, meaning that most of the experimental class had scores between 27-28 out of the maximum total score of 32. The minimum posttest score for the experimental class was 24 and the maximum score was 30. The standard deviation value was 1.63. with an average score of 27.63, it means that the data is less varied because the standard deviation value is less than the mean. Meanwhile, in the posttest results of the control class, an average score of 21.7 was obtained, meaning that most of the control class had scores between 21-22 out of the total maximum score of 32. The minimum posttest score for the control class was 18 and the maximum score was 26. The standard deviation value was 2.10 with an average score of 21.7, meaning the data is less varied because the standard deviation value is less than the mean.

Based on the average posttest score for the experimental class and control class, the variance and standard deviation in the experimental class, namely 2.65 and 1.63. Meanwhile, the variance and standard deviation in the control class were 4.42 and 2.10. This

means that the variance of the control class is greater than the experimental class. This causes the distribution of data in the control class to be more heterogeneous than in the experimental class, it means that the mathematical problem solving ability scores of students in the control class are more varied and spread out relative to the class average.

Then hypothesis testing was carried out to find out whether it was true that the problem solving abilities of students who were given learning using the PBL model had an effect. Previously, normality and homogeneity testing calculations were carried out on student problem-solving ability data.

A summary of the results of the normality test at the significance level α = 0.05 can be seen in Table 5.

Table 5. Normality Test Results for Experimental Class and Control Class

One-Sample Kolmogorov-Smirnov Test			
		Posttest Control	**Posttest Experiment**
N		30	30
Normal Parameters	Mean	67.8150	86.3563
	Std. Deviation	6.57313	5.09139
Most Extreme Differences	Absolute	.157	.133
	Positive	.101	.118
	Negative	-.157	-.133
Statistical Tests		.157	.133
Asymp. Sig. (2-tailed)		.059	.188

Based on Table 5, the results of the normality test using Kolmogorov-Smirnov analysis at the significance level show that the score data from the mathematical problem solving ability test of students in the experimental class and control class is normally distributed, this is obtained by comparing the significance value of the calculation results with those that have been determined. The significance value of students' mathematical problem solving ability scores in the experimental class was 0.188, greater than the value α (0.188 > 0.05) and the significance value of students' mathematical problem solving ability scores in the control class was 0.059 which was alsogreater than the value α (0.059 > 0.05).

The next prerequisite test is a homogeneity test for the two groups using the SPSS program. The output of the test in Table 6.

Table 6. Homogeneity Test Results for Experimental Class and Control Class

Test of Homogeneity of Variance				
	Levene Statistics	**df1**	**df2**	**Sig.**
Based on Mean	1.776	1	58	.188
Based on Median	1.190	1	58	.280
Based on Median and with adjusted df	1.190	1	54.481	.280
Based on trimmed mean	1.844	1	58	.180

Based on Table 6, the results of the homogeneity test at the significance level α = 0.05 show that the score data from the mathematical problem solving ability test of experimental class and control class students have the same or homogeneous variance. This is obtained by comparing the significance value of the calculation results with what has been determined. In the table 6. the significance value is 0.188 with F-value is 1.776. Based on the criteria that have been determined, if significance 0.188 > 0.05 or $F_{calculation}$ (1.776) < F_{table} (4.01) so the sample group has a homogeneous variance.

Based on the prerequisite test results for data analysis from both groups, it is known that the experimental class and control class have a population that is normally distributed and that both groups have the same variance, which means the two groups are homogeneous so that the requirements for testing the difference between the two averages are groups can now be carried out for the next stage in concluding the initial hypothesis that has been determined. The test used is a test of the similarity of the averages of the two groups. The data from the calculation of the similarity of the two averages is presented in the following Table 7.

Table 7. T-Test Results (Independent Samples t-Test)

Students' Mathematical Problem-Solving Ability		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Score	Equal variances assumed	1.776	.188	12.214	58	.000
	Equal variances not assumed			12.214	54.588	.000

From the homogeneity test results, it was found that the sig. = 0.188 is in the Equal variances assumed row. Meanwhile, the significance of the t-test is read on the same line as the Sig value. (2-tailed) with a significance of 0.000 with a t-test value of 12.214 and F-value of 1.776. Based on the criteria that have been determined, if significance $0.000 < 0.05$ or $t_{calculation} > t_{table}$ (12.214 > 2.002), then H_0 is rejected and H_a is accepted, it means that there is an effect of PBL model on students' mathematical problem-solving ability in class VIII SMP Negeri 35 Medan.

This study involved two classes, namely class VIII 7 (experimental class) and class VIII 6 (control class). Before being given treatment, both classes were given a pretest to determine the students' initial abilities. After the pretest was carried out, the two classes were given different treatment. The experimental class was treated using the Problem-Based Learning (PBL) model, while the control class was treated using the conventional model.

This study shows that the mathematical problem-solving abilities of students taught using the Problem-Based Learning model are higher than those taught using conventional learning. This is in line with research conducted by Arni, entitled "The Effect of the Problem Based Learning (PBL) Model on Problem Solving Ability Students' Mathematics in Class VII of Comparative Material SMP Swasta PAB 1 Klumpang Academic Year 2020/2021" with the

conclusion that problem-solving abilities students' increases by using the Problem-Based Learning model. In this study, the data analysis is using t-test, while the research conducted by Arni using simple regression test.

In line with the research conducted by Nasrullah and Nurlia (2021), entitled “The Effect of the Implementation of Problem-Based Learning Models on the Mathematical Literacy Ability of Grade 7th Student’s” with the result showed that the problem based learning model had a positive and significant effect on increasing students' mathematical literacy. In this study, the variable that used is Problem-Solving Ability while the research conducted by Nasrullah and Nurlia, the variable that used is Mathematical Literacy.

The Problem-Based Learning (PBL) model is a learning model that emphasizes students to think by collecting various concepts they have learned from various sources to solve problems and is meaningful as a first step for investigation and research. The phases of the PBL model applied in this study consist of 5 phases, namely orienting students to problems, organizing students to learn, guiding individual and group investigations, developing and presenting results, and analyzing and evaluating the problem solving process.

The implementation stages carried out by researchers during the research, at the first meeting there were still several obstacles in the learning process, starting with the researcher giving an explanation of the PBL model and instructions for using Student Worksheets or LKPD, but there were still many students who were confused so they asked the researcher a lot about what they would write in the LKPD. Apart from that, another obstacle experienced by researcher is that students' knowledge of previous topic/prerequisite material is still low, even though the PBL model requires students to collect information from various sources, one of which is in previous material/prerequisite topic.

At the second and subsequent meetings, students begin to understand and get used to the PBL model, students begin to learn to remember previous topic, and are able to fill in the directions in the LKPD independently. This improvement was achieved from learning from the first day of research. Although there are still some students who still lack interest and cannot concentrate in studying.

The results of this study show that students’ mathematics problem-solving abilities taught through learning using the PBL model is better than students taught using conventional learning model. This can be seen from the posttest average obtained by students in the experimental class which is higher than students in the control class. Differences in mathematical problem-solving abilities are described in the form of differences in average scores obtained from the different learning models used.

Learning process with the Problem-Based Learning (PBL) model which focuses on improving four indicators of problem-solving ability, namely understanding the problem, devising a plan, carrying out a plan, and looking back. The question instrument in the mathematical problem solving ability test is based on four indicators that have been determined based on the operational definition that has been made. The increase in mathematical problem solving abilities using PBL can be seen from the analysis of the posttest results for both classes showing that the PBL group students' answer scores were

better than the control class and the experimental class students' mathematical problem solving abilities were better than the control class.

Learning strategies problem-based learning (PBL) approaches that focus on improving four indicators of problem-solving ability, namely problem understanding, devising plan, carrying out plan and looking back. The questionnaire item of the mathematical problem-solving ability test is based on four measures that are determined on the basis of the task description developed. The increase in the ability to solve mathematical problems using PBL is clearly evident from the analysis of the post-test results of both classes, which shows that the response value of the students in the PBL group was better than that of the control group.

CONCLUSION

Based on the results of the analysis and discussion, students' mathematical problem-solving abilities were learning taught using the Problem-Based Learning model had an average value of 27.63. Meanwhile, the mathematical problem solving abilities of students were learning taught using conventional learning model had an average value of 21.7. For the t-test result is $t_{calculation} > t_{table}$ = 12.214 > 2.002, then H_0 is rejected. So, it can be concluded that there is an effect of the Probelm-Based Learning model on students' mathematical problem-solving abilty of class VIII at SMP Negeri 35 Medan. Based on the research results that have been obtained, several suggestions for next researcher, for further research, especially mathematics education students, are to research more deeply into students' mathematical problem-solving abilities and a variety of other learning methods.

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