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Students' Mathematic Problem Solving Ability with Problem Solving Learning Model in Class VII SMP Negeri 2 Singkawang

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Abstract

Students still need to improve their capacity for solving mathematical puzzles. The study aimed to evaluate how well the Problem-Solving learning model helped students become more adept at solving algebra-related mathematical problems. This study is an illustration of hybrid research (Mixed Methods). Class VIIA served as the experimental class, and Class VIID served as the control class for the study. Test forms, observation forms, and interviews served as instruments. Statistics are used in quantitative data analysis, whereas in qualitative data analysis, data is reduced, presented, and conclusions are drawn. The findings revealed that: (1) Mathematical problem-solving skills were improved in Problem-Solving Learning Model classes compared to classes using the Discovery Learning Model; (2) The Problem-Solving Learning Model defined what was meant by active student participation in class, with the percentage of student activity obtained being 41.12% at the first meeting with the quite active category and 89.74% at the second meeting with the very active category.

Keywords: problem-solving models; problem-solving skills; activity.

I. Introduction

Mathematics is an essential science because it teaches students to think clearly and systematically, preparing them to face the challenges of real life. Educators design mathematics instruction intending to help students; they cultivate original thought processes and acquire new information to understand better the subject matter (Mawaddah & Maryanti, 2016). Students are allowed to use what they have learned to find answers to problems outside their comfort zone, and problem-solving skills become a central part of any mathematics curriculum (Bidasari, 2017). Since one of the main reasons for learning and practicing mathematics is to improve Problem-solving skills, mathematics has a wide range of applications, not just math classes.

Fazzilah, Effendi, & Marlina (2020) argues that students' poor ability to solve problems, especially those related to PISA, is because students need more opportunities to practice Problem-solving and answer standard questions. The best way to solve a problem is to break it down into its parts and work on them one by one, starting with a thorough analysis of the Problem at hand, moving on to a detailed plan that specifies the actions to be taken to implement the strategy, and then looking again at the result. When working on a non-routine problem, students are expected to understand the content and intent of the given Problem. If students need help understanding the content of

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the Problem, the mathematical concepts used to solve the problem will be correct (Buyung & Sumarli, 2021). Mathematical Problem-solving in this context is defined as the ability to solve non-routine problems that require readiness, originality, knowledge, and practical application.

Branca (Reski et al., 2019) stated the importance of mathematical Problem-solving skills for students, including a) Mathematics education aims to cultivate Problem-solving skills, b) The primary focus of the mathematics curriculum is Problem-solving, which includes a variety of strategies, methods, and approaches, c) Problem-solving is basic skills in learning mathematics. Understanding how to solve problems and find solutions is a complex cognitive activity, and solving math problems is no exception. Revealed that by solving problems, students will learn to develop appropriate strategies to solve the problems they face (Utami & Wutsqa, 2017). Students are required to mastery of problem-solving skills by getting used to giving non-routine problems so that students can think using prior knowledge related to the problems they face, which in the end, students can find strategies to solve these problems.

Students' mathematical Problem-solving ability is also low at SMP Negeri 2 Singkawang class VII; according to interviews with mathematics teachers, students often take too long to analyze problems, thus wasting time in class. Furthermore, the teacher said that students rarely looked beyond the teacher's own example when solving problems, found it difficult to find their own problems, and generally viewed mathematics as a complex subject.

Initial findings are given by giving a mathematical problem-solving test with indicators, namely first identifying the Problem; then developing strategies for dealing with them; then put that strategy into action; Finally, rechecking the work. Current students' mathematical abilities still need to be revised. This is explained in the first indicator, 14 students (78%) who answered correctly and 4 students (22%) who had difficulty writing both what was known and what was asked in the question. According to the second indicator, 6 students (or 33% of the class) were able to create a plan to solve the issue, while 12 students (or 67% of the class) were unable to do so. In the third indicator, 7 students (or 39% of the class) correctly solved problems, while 11 students (or 61% of the class) still needed to implement their problem-solving strategy fully. In the fourth indicator, 5 students (28%) answered correctly, while 13 students (72%) needed to be more precise in re-examining answers and making conclusions. According to Mariam et al. (2018), students' problem-solving skills in mathematics can be traced back to their inability to apply the knowledge they have acquired in other contexts, to translate that knowledge into concrete examples and to understand basic concepts.

Observational data from SMP Negeri 2 Singkawang indicates that student engagement is still low. Some students did not pay attention to the teacher's explanation but instead engaged in activities that had nothing to do with mathematics; if the training was offered, only a small percentage of students took advantage of it, and still, others had trouble accepting the material explained by the teacher. Students engage in learning activities as part of the learning process intending to achieve specific learning outcomes, so a lack of activity can obviously impede learning (Nuraini, et al., 2018). Anything a student does to further his or her education is considered a learning activity, whether physical or mental (Rahmadani & Anugraheni, 2017). As a result, everything that takes place, physically or mentally, can be classified as an activity.

Acting in response to an external stimulus and subsequently modifying one's behavior constitutes activity (Zakiah et al., 2019). Individual experiences or responses to a stimulus in the interaction between students produce knowledge, understanding, skills and values, attitudes, and behaviors, which students actively engage in learning activities to progress towards acquisition. Student activities while studying can be observed during learning. The increase in the proportion of students taking an active role in learning can be attributed to a general increase in the number of students engaged in the activity (Nurfitriyanti et al., 2020). The best learning activities challenge students to think critically, apply what they have learned, and find practical solutions to real-world problems.

Learning activities can be realized if students are actively involved in learning. Active learning is an effort to foster creativity to foster innovation (Nasikhah, 2020). Student's aptitudes, expertise, and knowledge will all grow and develop as a result of their educational experiences.

Mental and physical actions taken by students as they engage in learning constitute a sequence of "activities" that, depending on their level of engagement with their environment, may result in different behavior patterns. Research indicators include: (1) Visual activities include everything that requires students to use sight, read, or concentrate; (2) Students engage in speaking activities when they practice (oral) communication skills; (3) student work activities that involve writing are called writing activities; (4) Activities that make students get up and move are known as moving activities (Dewi et al., 2019).

Student problem-solving skills and engagement levels are low enough that an alternative approach to education is required. Problem-solving instruction, as defined by (Shogren & Wehmeyer, 2017), gives students practice applying previously acquired knowledge and skills to novel situations. The Problem-Solving Learning Model aims to help students develop higher-order thinking skills by teaching them to solve problems using the resources at their disposal (Afifah et al., 2019). Students can hone their higher-order thinking skills through the Problem-Solving learning model, which involves a learning activity in which they are presented with a problem they are unfamiliar with and are asked to solve by applying the steps or strategies they have learned.

The Problem-Solving model was applied in five stages: 1) identifying the issue; 2) developing a strategy for fixing it; 3) carrying out the strategy; 4) evaluating the outcome; and 5) concluding. The advantages of Problem-Solving learning model according to M. Ariyanto, F. Kristin (2018), the benefits of the Problem-Solving learning model include: fostering an environment that promotes curiosity and experimentation; fostering the development of critical thinking skills; fostering the ability to effectively communicate ideas and information through speech, writing, graphs, maps, and diagrams; fostering an environment that promotes the pursuit of knowledge; highlighting similarities, differences, consistent and inconsistent evidence; etc. The benefits of the Problem-Solving learning model include making school more relevant to real life, especially the world of work, and teaching students how to design an invention, think creatively, solve problems in a realistic manner, conduct investigations, interpret and evaluate the results of observations, and stimulate the development of students' thinking progress to solve problems appropriately (Setiyadi, 2020).

The content of algebraic forms is a method that can help in improving students' ability to solve mathematical problems. According to Romlah, et al. (2017), the material on algebraic forms is very important because it explains the basics of working with integers and identifying variables, coefficients, and terms from algebraic expressions. Students will find abstract symbols and algorithms in algebraic form throughout this content. Solving algebraic forms involving the identification of variables, coefficients, and terms are all topics that benefit significantly from a thorough understanding of algebraic form material (Marfiah & Pujiastuti, 2020). This study set out to answer the question, "Does the Problem-Solving learning model help students become active and proficient at solving mathematical problems in an algebraic context?" by testing this hypothesis.

II. Research Method

This study employs a sequential explanatory research design and is part of the fusion research (Mix Method) (sequence of proof). This research employed a simple random sampling strategy, in which samples were selected randomly without considering preexisting population subgroups. At SMP Negeri 2 Singkawang, class VIIA will be the experimental group to test the Problem-Solving learning model. In contrast, class VIID will serve as the control group to test the Discovery Learning learning model.

The following is a description of how the data in the study were collected. a) the test method is a device used in the context of measuring and assessing, and usually in the form of a series of questions to be answered by the person or object being studied; b) the method of observation, namely data collection carried out to see student involvement in the learning process; c) interview method, is a procedure used to evaluate students' potential to solve mathematical problems. In the study, the researcher collected data using tests, observations, interviews, and written notes. This qualitative study uses triangulation to ensure the validity of the data findings, increase persistence and use reference materials (Sugiyono, 2020).

Some standard data analysis methods in quantitative research include normality, homogeneity, and hypothesis testing. Given the lack of correlation between the samples, *Chi-Square* was used to ensure that the data fit a normal distribution. The *F test* was used to check for data regularity across the board.

Hypothesis testing seeks to isolate potential differences in how students learn to solve mathematical problems. The researcher used a two-sample *t-test* to check for normality and homogeneity in the data. The two-sample *t-test* statistic is presented below.

$$t_{count} = \frac{\overline{x_1} - \overline{x_2}}{s_{combined}\sqrt{\frac{n_1 + n_2}{n_1 . n_2}}}$$

By formula:

$$s_{combined} = \sqrt{\frac{(n_1 - 1)\, s_1^2 + (n_2 - 1) s_2^2}{n_1 + n_2 - 2}}$$

Description:
t = t-test
$\overline{x_1}$ = the average value of the post-test results of the experimental class
$\overline{x_2}$ = the average value of the post-test results of the control class
s_1^2 = experimental class variance
s_2^2=control class variance
n_1 = many experimental group students
n_2 = many control group students
(Lestari & Yudhanegara, 2015)

To analyze the results of this qualitative study, the researcher followed the method proposed by Miles et al. (Sugiyono, 2017), which is data reduction. This study uses the following steps to reduce the data. 1) Correcting student test work results. 2) Student projects that will be used as research subjects are changed from raw data to interview notes. 3) The results of the information obtained from interviews are cleaned into an orderly structure and then converted into usable information. Data presentation is done after data reduction. The data will be presented to make it easier to draw conclusions and take the necessary next steps.

In the third phase, conclusions are drawn, and evidence is gathered. All qualitative data analysis resulted in new findings. Research results can be presented in various formats, including descriptive language, causal/interactive relationships, hypotheses/theories, and predictions.

III. Results and Discussion

The results of the quantitative and qualitative analyses are discussed in this report. This research aims to evaluate the efficacy of the Problem-Solving learning model in boosting students' ability to solve algebraic problems at the junior high level. The following data is gathered by analyzing how well students do on tests of their ability to solve mathematical problems.

Table 1.
Data recapitulation of pretest and posttest values

	Experimental class		Control class	
	Pretest	Posttest	Pretest	posttest
Amount	829.16	1387.49	712.49	1312.5
average	46.064	77.08	39.58	72.9167

This is based on the data in Table 1. The average score on the test measuring the most accurate way to assess students' aptitude for solving math problems rose from 46.064 to 77.08 after being administered to students in the experimental class both before and after the intervention. Students' mathematical problem-solving skills also improved over time in the control group, as evidenced by pre-and post-test results showing an increase from an average score of 39.58 to an average score of 72.9167. In both the experimental and the control groups, the posttest value is higher than the corresponding pretest value. This has gotten better over time. The overall picture reveals that the experimental class's students are distinct from the control group in terms of their aptitude for mathematical problem-solving.

The *N-Gain* calculation for the experimental and control groups will be displayed in Table 2 and Table 3, depending on the problem-solving success indicators used in each.

Table 2.
Recapitulation of N-Gain on each experiment class indicator

	Experiment Class			
	Indicator 1	Indicator 2	Indicator 3	Indicator 4
Amount	3.78	6.11	6.11	2.5
average	1.89	3.06	3.06	1.25
N-Gain	0.85	0.60	0.54	0.46

All indicators of student's ability to solve mathematical problems are the same between the experimental and control groups (Tables 2 and 3), except for the N-gain value (which is high for the experimental group in the first indicator, low for the second, third, and fourth indicators, and medium for the fifth indicator). Except for the second indicator, where the N-gain for the experimental group and the control group scores was the same, the N-gain value indicated that students in the experimental group generally improved more in solving math problems than the control group. It is the first indicator that's the highest one.

Table 3.
Recapitulation of N-Gain on each control class indicator

	Control Class			
	Indicator 1	Indicator 2	Indicator 3	Indicator 4
Amount	2.28	2.33	3.66	1.28
average	1.14	1.17	1.83	0.64
N-Gain	0.78	1.60	0.55	0.31

The experimental group improved their ability to solve mathematical problems more after being exposed to the learning model used by Problem Solving compared to the control group, who were exposed to the Discovery Learning model. Students in the experimental class (class VIID) who were taught using the Problem-Solving learning model outperformed their counterparts in the control class (class VIIC) on standardized tests measuring their ability to solve mathematical problems (class VIIB). The combined N-Gain Index for all of the experiments comes in at 0.57, placing it in the medium range, while the N-Gain Index for the control group, while still in the middle range, (0.55) meets the low threshold.

The independent sample t-test was used to compare students' progress in a class using the Problem-Solving learning model (the experimental class) and a class using the Discovery Learning learning model (the control class). An initial t-test is performed on data from two independent samples to check for normality and homogeneity.

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Table 4.
Normality calculation results for experiment class and control class

Class	x^2_{count}	x^2_{table}	Description
Experiment	-512.782	27.587	Normal
Control	-420.1107	27.587	Normal

From the data in table 4, it can be seen that the *N-gain* data in the experimental class $x^2_{count} \leq x^2_{table}$ that is $-512.782 \leq 27.587$. While the *N-gain* data in the control class $x^2_{count} \leq x^2_{table}$, that is $-420.1107 \leq 27.587$, Which means Ho is fine while Ha is not. Therefore, there is a normal distribution underlying both the experimental and control class *N-gain* data.

The *f-test* will also be used for the homogeneity analysis. Suppose there is no significant difference between the experimental and control groups regarding the variance of the N-gain data. In that case, a decision can be made based on $F_{count} \leq F_{table}$ use $\alpha = 5\%$ (homogeneous). The results of the homogeneity calculation is presented in table 5.

Table 5.
Results of calculation of homogeneity of *N-gain* data for experiment class and control class

Class	Variance	F_{count}	F_{table}	Description
Experiment	0.01	0.5	2.27	Homogeneous
Control	0.02			

Based on Table 5 calculating the homogeneity of the *N-gain* value with the homogeneity of variance test, the results are obtained as $F_{count} \leq F_{table}$, which is $0.5 \leq 2.27$. Therefore, the variance of the experimental and control groups has a homogeneous *N-gain* value.

Two independent sample t-tests can be performed after determining that the experimental and control classes' N-gain data are normal and homogeneous. Based on the *t-test of two independent samples*, it was found that $t_{count} > t_{table}$ that is 3.00 > 2.032. Therefore, the experimental group differed significantly from the control group, and the experimental class students' ability to solve mathematical problems was greater than that of the control class students at the 5% or 0.05 level of significance.

Observation data results from student learning activities as long as they learn to use the Problem-Solving model in the algebraic material form. Observation of the activities carried out consisted of (1) visual activities; (2) speaking activities; (3) writing activities; (4) moving activities. Student activity at the first meeting was observed to be 41.12%, falling into the moderately active category; at the second meeting, this number rose to 89.74%, placing it firmly in the very active category. This is due to the fact that students are expected to take an active role in their own education when using the Problem-Solving learning model. The Problem-Solving learning model encourages students to take an active role in their education through the stages of Problem-solving, preparation, implementation, review, and conclusion. Visual activity the percentage of students who were actively involved was 14.03% at the first meeting and 31.12% at the second meeting. At the stage of re-examining the answers obtained, students analyzing the problem-solving process (talking activities) got a percentage of 6.53% at the first meeting and 15.28% at the second meeting. When solving problems, students are connected or look for information from the material studied (writing activity) gets a percentage of 9.03% at the first meeting and 19.17% at the second meeting. In the moving activity observation category, the percentage of actively involved students was 11.53% at the first meeting and 24.17% at the second meeting.

Activity is the main component of the learning process, so without activity, the learning process cannot occur (Prastuti et al., 2019). Teachers must encourage their students in classroom activities that get them moving and thinking. This is a great way to keep them engaged in what they are learning to use their imagination and critical thinking skills. Student participation in class activities is a crucial factor in the success of the learning process. One indicator of success in the learning process is the participation of students in each learning activity (Wihartanti, 2022).

This is in line with the opinion of Bruner (Hatip & Setiawan, 2021); when a teacher helps them learn a theoretical or conceptual concept by providing real-world examples, learning goes more smoothly, actively, and creatively. Based on Bate'e & Zebua (2019) shows that the Problem-Solving model is better than the conventional learning model. The Problem-Solving learning model stage has stages that can activate students, namely at the stage of solving or solving problems; at this stage, students are required to analyze, develop, expand, find, and use because Bruner's theory emphasizes discovery learning, and this stage the model also emphasizes on the process of discovering, Thus, students' activity and creativity are very important if they are to discover theories, rules, or understandings through examples.

These results show students' Problem-solving abilities in algebraic form after the Problem-Solving learning model is applied. Algebraic concepts are closely related to problems in everyday life encountered by students, so instilling the initial concept for algebraic form material in students is very important (Sari & Afriansyah, 2020). Algebraic form material was chosen because this material it is taught how to simplify sentences into a mathematical model to make it easier for students to solve problems so that if students encounter problems in everyday life, they can use the knowledge they already have to solve these problems (Wibowo & Faizah, 2021). Students in the "high" category on the first indicator, namely understanding the Problem, being able to recognize the conditions or problems given, and responding appropriately with known and asked information. Students can make a correct resolution plan in the second indicator, namely the problem-solving plan, from known and unknown data. In the third indicator, namely carrying out the plan, students can complete the complete wholly and correctly. Furthermore, finally, indicator number four is rechecking; students can check the results obtained and make conclusions from the Problem.

With regard to the first indicator, namely understanding the Problem, students with moderate mathematical Problem-solving abilities can recognize the conditions or problems that exist in the Problem and provide relevant information, and are asked about the Problem. In the second indicator, namely the completion plan, students can make a correct settlement plan from known and unknown data, but it still needs to be completed. In the third indicator, namely carrying out the plan, students can carry out the completion plan correctly and may produce the correct answer, but it still needs to be completed. Furthermore, the fourth indicator is rechecked; students must prove that the results are correct. Students only write conclusions from the Problem.

Students with limited problem-solving abilities can still answer questions requiring them to provide the information they already know, but this is only the first indicator. In the second indicator, namely the problem-solving plan, students can make a plan for solving the Problem. Students demonstrate the ability to successfully implement the completion plan on the third indicator, namely implementation, but the answers obtained by students still need to be completed. Furthermore, the fourth indicator is rechecked; students cannot prove that the results obtained are correct, and students need to provide conclusions from the Problem.

The results of qualitative data analysis in the form of Problem-solving tests and interviews with students, two students have high Problem-solving abilities, two with low abilities, and two with moderate abilities. Students with strong problem-solving skills are twice as likely to have strong math problem-solving skills. After taking the post-test, students should be able to analyze the problem, develop a strategy to solve it, apply the strategy, evaluate the results, and draw conclusions. The 38.89% of naturally gifted students in this area saw their Problem-solving skills in mathematics improve. Students' understanding, solution planning, and implementation improved after the post-test, making conclusions from the Problem but needing help to re-examine the answers. Furthermore, 11.11% of Students with fewer resources have improved their math problem-solving skills. After being given a posttest, students need to be more precise in understanding the Problem, unable to draw conclusions from the Problem or re-examine the answers that have been found to produce new ones, plan irrelevant solutions, and fail to solve the problem.

According to Sumartini (2016), Achieving educational goals, such as helping students become more proficient at solving math problems, requires using effective and appropriate teaching strategies. Students are expected to be able to solve problems as part of the Problem-Solving learning model. For students to be more active in studying the material, the first step in understanding the Problem involves guiding them on related problems. In the second step, namely planning Problem-solving, students determine the steps or strategies to overcome the problems at hand. The third step is solving the Problem; students are required to solve the problem according to the second plan. The first, second, and third steps can arouse students' interest in the material Students can learn more and work together more effectively in groups if given the opportunity to discuss topics of interest. Students are encouraged to participate in class discussions and other group activities through intra- and extra-group interactions. Then in the fourth step, students check the results obtained, followed by the fifth step, concluding the Problem. Learning activities can be improved by using the Problem Solving model. Using the Problem-Solving learning model, students are encouraged to take an active role in their education by engaging with the material, thinking critically about it, and finding original ways to tackle the challenges presented (Maesari et al., 2020).

IV. Conclusion

The study found that seventh graders at SMP Negeri 2 Singkawang used the Problem-Solving learning model faster than those using the Discovery Learning model.

As long as algebraic material is studied using the Problem Solving Learning Model, we classify student activity as active, with the percentage of student activity obtained being 41.12% for the group that we call quite active at the first meeting and 89.74% for the group that we classify as very active at the second meeting.

The data description of students' problem-solving abilities shows that students with high problem-solving abilities have shown growth in several areas, including assignment preparation and completion, assignment implementation, and review of previous student work. Indicators of completion planning and indicators of implementation of completion plans show that students with problem-solving abilities are improving in these areas. Students with low problem-solving skills have improved in their ability to solve mathematical problems, as measured by a number of different indicators. Student growth in solving mathematical problems in Algebra 2 at SMP Negeri 2 Singkawang is evidence that the school's implementation of the Problem-Solving learning model is successful.

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