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Application of *Problem-Solving* Approach Using Model *Problem Based Learning* to Improve Ability Problem Solving and Student *Self-Efficacy*

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ABSTRACT

To improve students' *problem-solving* abilities and *self-efficacy*, this study seeks to ascertain the impact of teaching mathematics using a *problem-solving* strategy. With a *one group pretest-posttest* design, a quantitative method was adopted. Using a basic random selection technique, a sample of VIII C grade students from one of the State Junior High Schools in Yogyakarta served as the study's population. In this study, a *self-efficacy* questionnaire, an observation sheet, and a *problem-solving* skill test were utilized to collect data. Because the N-Gain score data were evenly distributed and homogeneous, data analysis was done using IBM SPSS statistical software version 21 and the t-test. H_0 is rejected when the statistical significance results show that equal variances are not considered to be 0.00 less than 0.05. The findings indicated that students who utilized a *problem-solving* method while using a problem-based learning model did better in mathematics after studying using a *problem-solving* strategy while using a *problem-based learning* model.

Keywords: *Problem Based Learning*, *Problem Solving* Abality dan *Self-Efficacy*.

1. Introduction

One of the disciplines that is taught at every type and degree of school and is considered a fundamental science in all professions is mathematics. This is so because math is crucial, especially in the twenty-first century. Students who study mathematics gain a variety of skills, including the capacity to solve problems.*Problem-solving* abilities are a crucial component of all mathematics learning; hence they should not be treated separately in the mathematics curriculum, according to NCTM (2000). Being an effective problem solver can be very advantageous in both business and daily life (NCTM, 2000). According to Ponapichat, et al. (in Jayanti, et al.: 2018), the goal of learning mathematics in school is for children to be able to answer issues in daily routine.

Self-efficacy is one of the affective domains needed to promote *problem-solving* skills. A person's *self-efficacy* is their sense of their own abilities. According to Bandura (1994), perceived *self-efficacy* refers to people's attitudes of their capacity to deliver a particular caliber of performance that has an impact on the events that affect their lives. *Self-efficacy* beliefs influence people's feelings, thoughts, motivation, and behavior. These beliefs have a variety of effects due to four major mechanisms. They involve selection, emotional, cognitive, and motivational processes. *Self-efficacy* in a classroom setting refers to pupils' level of assurance in carrying out specific activities. The ability to successfully execute activities in mathematics, such as grasping concepts and solving problems, is known as mathematical *self-efficacy* (Masitoh, 2017). Students are expected to have problem-solving abilities and a sense of self-efficacy to successfully complete the mathematical learning objectives.

However, children still have poor problem-solving abilities and levels of *self-efficacy*. Abda (2020) Because learning is one-sided and students are not actively involved in investigating mathematical concepts or ideas, they have a limited capacity to apply mathematics in life, which makes them despise learning math. Additionally, students' self-confidence has not improved.The findings of observations and interviews with local eighth grade instructors at one of Yogyakarta's junior high schools, which showed that the students' arithmetic skills were below average because they were not accustomed to contextual problems, confirm this. This is due to the impact of the post-Covid19 pandemic which is often online learning which affects *self-efficacy* (Alemayehu, 2023), where students are usually used to learning online now must adjust again to learning offline. Online learning can improve students' mastery of concepts in the post-Covid-19 period (Amanda, 2022), differing from the Covid-19 pandemic which was still less interactive,renderinglearning less effective. Thus, the introduction of a new curriculum also rendered the utilized textbooks unstructured but still relevant to solving contextual problems in the Merdeka Curriculum. Algebra material is abstract material that requires a high level of understanding and learning that is not organized between the connection of material to material is also the cause of not optimizing students' *problem-solving* skills and *self-efficacy*.

To overcome these problems, teachers must package the material to be delivered to students by choosing the appropriate innovative model so that it can be utilized with the aim of promoting student learning and preventing laziness in learning. Packaging material that has a positive impact on students is the *problem-solving* approach. According to Gagne (1983), *problem solving* is the highest level and most complex type of learning compared to the type of learning that begins with simple prerequisites and then increases to complex abilities. Gagne's idea of a series of learning is suitable to be applied in mathematics learning, because if we pay attention,the concepts in mathematics are arranged hierarchically. The packaging of the innovated material is by using a cooperative model of *Problem-Based Learning* (PBL).

PBL is education where issues are used as the basis for learning. PBL places a focus on the process of resolving issues arising from complicated and chaotic daily living. PBL is another type of learning that can provide students the chance to actively participate in the classroom. According to the justification provided, *problem-solving* is a very effective way to help students develop their *problem-solving* abilities and *self-efficacy* through *problem-based learning*. Can the problem-solving strategy of the *problem-based learning* model improve *problem-solving* abilities and *self-efficacy* based on the description of the challenges mentioned above?

2. Literature Review

2.1 *Problem Solving*

The *problem-solving* approach is an important part of the mathematics curriculum. *Problem solving* as a learning approach was introduced by John Dewey. John Dewey developed a *problem-solving* approach resembling the inquiry method, careful planning, and systematic skill building. So that the *problem-solving* approach focuses on the concept of experience (Falach, 2016). In the *problem-solving* approach, students are emphasized to be able to use the knowledge and skills already possessed in the learning experience to be applied in solving problems that are not routine. Cockcroft (Husni, 2014) said that *problem solving* is a tool to advance mathematical thinking skills and *problem-solving* abilities as the core of mathematics. According to other experts, providing conceptual instruction before *problem-solving* is a more effective sequence of activities than vice versa (Fyfe et al., 2014). Fyfe et al. explained that when *problem-solving* activates challenging misconceptions, it seems that prior conceptual instruction would be beneficial. To teach *problem-solving*, there are some basic skills that must be taught to students. Fox & Surtees (2010) suggest some basic skills as an amplifier for students in applying *problem-solving*, among others:

a) Using strategies such as pictures, lists, tables, graphs, and diagrams to display the problem.
b) How to organize and interpret the collected information
c) How to read the core text to find information and make notes on aspects that contradict the obtained information
d) How to find clues in story problems to avoid being trapped by the amount of available information.
e) Solve problems with the same structure.
f) Compile results without needing assistance in discovery,
g) Finding patterns from the results or answers found,

h) Using a range of tactics
i) Collaborate to find a solution.
j) Checking results and testing hypotheses
k) Pointing out problems found to friends,
l) Effectively communicating with friends.

The basic skills that students already have can then be continued with the introduction of *problem-solving* to students. Bennett, Burton, & Nelson (2012) said that *problem-solving* is a process in which an unfamiliar situation is solved. Situations like this result in students not being able to achieve instantly or easily. Armed with the basic skills that students already have, there are various unique ways or strategies to solve problems. With this understanding, everyone has a different way to find the right answer (Bradshaw & Hazell, 2017). Based on the explanation above, the steps to package material based on problem solving are:

a) Starts with a non-routine problem.
b) Has a different solution
c) To be able to solve a problem, one must have a significant amount of experience.
d) Select problems that relate to real-life situations.
e) Develop scientific traits such as honesty, conscientiousness, openness, professionalism, and hard work.

2.2 *Problem-Based Learning*

A teaching strategy that places a high value on students' learning experiences is *problem-based learning*. In *problem-based learning*, Students aren't merely read or listen to facts and concepts, but students solve real problems that become problems in everyday life. As stated by Massa (2008) that "*Unlike traditional learning, where information is passively transferred from teacher to student. In problem-based learning, students play an active role in the learning process. This can lead students to confusing situations where the standard of solution is less clear and confusing like problems in the real world*". According to Arends (2014), a teacher's job in *problem-based learning* is to serve as a facilitator so that students can develop their ability to think critically and solve issues on their own. PBL is learning with problems as the starting point of learning. Relevant problems are introduced at the beginning of learning with PBL and are used to provide conditions and motivate students to learn. The problem presented in PBL becomes a means to learn through *problem-solving* activities. PBL can provide challenging, motivating, and fun learning conditions for students. In addition, in PBL classes students are active in learning to create a pleasant learning atmosphere (Masitoh, 2017).

Botty & Shahrill (in Masitoh, 2017) stated that in PBL students work in small groups to achieve learning targets. Students work in small groups related to real everyday situations. The steps of PBL are:

a. Problem orientation
b. Organizing students to learn.
c. Identifying the required disciplines and concepts.
d. Conducting research
e. Analyzing information and data
f. Presenting problem-solving ideas
g. Evaluate

(Amanda, 2022)

2.3 *Problem-Solving* Ability

Students can use reasoning on properties, perform mathematical manipulation both in simplification and analyses of existing components in *problem-solving* in the context of mathematics and outside of mathematics (real life, science, and technology), which includes the ability to understand problems, build mathematical models, solve models, and interpret solutions, according to the Ministry of Education and Culture (2014). In between, problem solving, reasoning & proof, communication, representation, and connections are the five components that pupils must possess, according to NCTM (National Council of Teachers of Mathematics). Solving problems is crucial since it is a fundamental human ability and a necessity for survival.

According to Barmby (in Wijayanti, 2013), a problem is an instance in which students (a) accept the challenge of demonstrating some mathematical tasks to achieve a specific goal and (b) do not yet know the mathematical procedures that will be used to achieve the mathematical goals to be achieved. Another way to describe an issue is as a scenario for which there is no known solution or approach. Mathematics education and learning revolve around solving problems. Astutiani (2019) claims that participating in a task whose solution approach is unknown beforehand constitutes issue solving. Learners must apply their prior knowledge to the problem to find the solution; frequently, this process leads to the development of new mathematical understanding.

Mathematical *problem-solving* is defined as attempting to accomplish certain results using as-yet-unknown techniques. As a result, we must put in a lot of effort to get the desired outcomes. Usman (2014) asserts that the ability and understanding of solving mathematical problems are essential to the teaching and learning of mathematics. The capacity to apply previously learned knowledge to solve problems in a variety of contexts is known as *problem-solving* ability (Trianto, 2007). Indicators are necessary to assess students' *problem-solving* skills. According to NCTM (2000), there are several markers that can be used to gauge a person's *problem-solving* skills, including:

a. Learners can identify the information required to obtain a solution to the problem.Learners can develop mathematical models,
b. Learners can apply strategies that have been prepared to solve various problems in mathematics and other sciences.
c. Learners can explain solutions obtained from problems they face, and
d. Students can utilize mathematics in meaningful ways, which means that solving mathematical problems does not strip mathematics of its significance. Concepts or principles acquire significance when they are applied for solving problems.

Polya (1957) *problem-solving* ability indicators are 4, specifically, pupils need to be able to understand the problem in the first portion, be able to collect and select existing information. Second, Students might organize a *problem-solving* strategy that connects previously learned material, how the unknown is connected to the data, and get ideas for *problem-solving* solutions and make plans. Third, implement the plan that has been designed to implement the solution plan by carrying out the ideas that already exist to discover the solution to the stated issue. Finally, students do a recheck to look back at the solution that has been completed, whether it is as expected or whether there are still other solutions that are more effective and efficient. Examples of steps and indicators of Polya's problem-solving approach can be seen in Table 1.

Table 1. Polya's Problem Solving Steps and Indicators

1. Understanding the problem	Students determine what is known in the problem and what is asked.
2. Planning for completion	Identify appropriate *problem-solving* strategies to solve the problem.
3. Solve the problem according to the plan	Carry out problem solving according to what has been planned.
4. Checking whether the results obtained have returned	In accordance with the provisions and there is no contradiction with what is asked.There are four important factors that can be used as guidelines in

	carrying out this step: matching the results obtained with what is asked, interpreting the answers obtained, identifying whether there are other ways to solve problems, and identifying whether there are other answers or results that fulfill the requirements.

Source: Astutiani, 2019

2.4 *Self-Efficacy*

In 1977, Bandura developed the social cognitive theory of *self-efficacy*. In some circumstances, a person's capacity for organization and decision-making is what Bandura refers to as *self-efficacy* (Bandura, 1995). According to Meral et al. (2012), *self-efficacy* is a measure of an individual's capacity to exert control over their ideas, feelings, and behaviors. It can also be defined as the confidence an individual has in their own skills and the extent to which their efforts have influenced others' perceptions of them. *Self-efficacy*, according to Santrock (in Saputra, 2016), is the conviction that one can exert control over events and produce the desired consequences. Self-efficacy, according to Bandura (in Subaidi, 2016), is a person's confidence in his ability to plan out and finish a work that is necessary to attain a specific goal. *Self-efficacy* has an impact on a person's thoughts, feelings, motivation, and behavior. *Self-efficacy* is the conviction that one is capable of accomplishing goals. *Self-efficacy* in an academic setting refers to how confident students are in their ability to do tasks (Masitoh, 2017).

A widely understood definition of *self-efficacy* is a sense of satisfaction with oneself (Lindenfield, 1997). A person who is satisfied with themselves does not feel inferior to others but feels that they have the same abilities as others and even that they have characteristics that others do not have. In addition, *self-efficacy* can also be interpreted as subjective knowledge.*Self-efficacy* in mathematics is specifically explained by May (in Masitoh, 2017) who states that a person's mathematical *self-efficacy* is his ability to successfully execute a variety of tasks, from comprehending concepts to working out mathematical problems. It is crucial to take note of mathematics *self-efficacy* because it significantly impacts math learning. The *self-efficacy* indicators according to Bandura (in Subaidi, 2016) which are used as the basis for measurement are:

a. Magnitude

The degree of task complexity that a person believes they can complete is related to this dimension.Individuals' *self-efficacy* will fluctuate between simple, medium, and difficult jobs depending on how far they believe they can progress in fulfilling the behavioral expectations for each level if problems or tasks are ordered according to a given level of difficulty. The choice of behaviors to attempt or avoid depends on the difficulty dimension. People will experiment with actions they believe they are capable of undertaking and avoid behaviors they believe are outside of their capabilities.

b. Strength

This dimension concerns how strongly or weakly a person believes in their own skills. Strong believers in their own skills tend to be resolute and tenacious in increasing their efforts when facing challenges. Individuals with low *self-efficacy*, on the other hand, often allow minor challenges to deter them from fulfilling their duties.

c. Generality

This dimension refers to the variety of tasks undertaken. Some individuals are more confident in a wide range of activities and situations than others when it comes to overcoming or fulfilling their tasks or problems.

Based on these indicators, the *self-efficacy* indicators that researchers use to measure *self-efficacy* include:

a. Confidence in being able to complete the task.
b. Belief that one can try hard, be persistent and diligent.
c. Belief in being able to achieve success (achievement)
d. Confidence in one's ability to handle a variety of challenges.

3. Methods

This study is quantitative in design. *Pre-experimental* research is a type of study that uses statistical formulas to assess data collected from research outcomes in numerical form. A *one-group pretest-posttest* research design, as suggested by Cohen (2007), was adopted in this study. The following table shows the design of this study:

Table 2. *One-group pretest-posttest design*

Pre-test	Treatment	Post-test
O_1	X	O_2

Source: Sugiyono (2018)

Keterangan:

X: Treatment using a problem *solving* approach of a problem-based *learning* model
O_1: Initial test score before treatment (pre-test)
O_2: Final test score after treatment (post-test)

This study was carried out during the sporadic semester of algebraic calculation operations in Class VIII C in Sleman Regency at one of Yogyakarta's State Junior High Schools. Purposive sampling was utilized as the sample method in this investigation. Students in class VIII C who received learning support utilizing the *problem-solving* method of the *problem-based learning* model served as the study's samples. The instruments utilized are *self-efficacy* questionnaires and test questions with indicators to enhance *problem-solving* abilities. The indications employed in this study have been described in CHAPTER II so that following treatment, students can work on test problems. The *self-efficacy* questionnaire has 14 questions, including 7 positive questions and 7 negative questions, and both the pre-test and post-test have 9 multiple-choice questions and 1 descriptive question that combines problem solving.

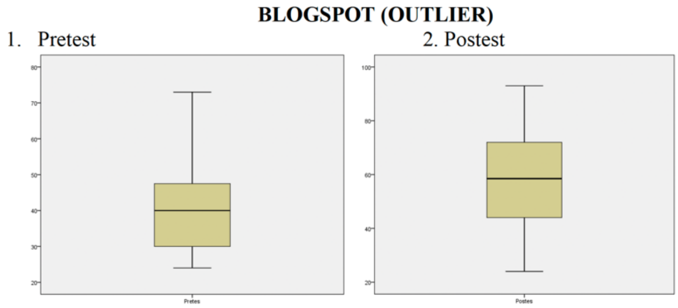
Next, a normality test and a one sample t test are included in the power analysis. Lestari and Yudha Negara (2007) describe the use of the *one-sample t test* for assessing research hypotheses on a small sample size of n 30 that involved only one treatment. Microsoft Office Excel 2013 was used to analyze the data. The normality test was performed first, followed by hypothesis testing. To ascertain if the data received from the research results are regularly distributed or not, a normality test is carried out. To determine the value of the chi-squared, a manual computation of the normality test was performed. There are 4 steps in the research process. The first step is the manufacturing of testing and non-testing research tools. Second, giving a pre-test comes in second during the initial implementation stage.Third, putting therapeutic learning into practice, administering a post-test exam at the conclusion of the lesson.

4. Results and Discussion

4.1 Results

According to the study's findings, students' *self-efficacy* and *problem-solving* skills improved more after using the *problem-solving* strategy from the *problem-based learning* paradigm. Because the p-value is < 0,05 or 0,00 < 0,05, H_0 is rejected, indicating that there is a difference between the pre-test and post-test values, students' math test results after learning with a *problem-solving* approach with a problem-based learning model are better than students before obtaining experimental learning. The results of the homogeneity and normality tests are used to determine this. The purpose of the normality test is to establish whether the pre-test and post-test data are regularly distributed. The homogeneity test, on the other hand, seeks to ascertain whether the pre-test and post-test data are representative of a homogeneous population. The results of the following Blogspot's normality test, which showed that the data is normally distributed, can be observed.

Figure 1. Data results are normally distributed.



Kolmogorov-Smirnov is used for the normality test. The normality test for this study was conducted using the *SPSS version 21* program with a significance threshold of α = 0.05. The following table shows the outcomes of the data processing that was done:

Table 3. *Kolmogrov-smirnov* Normality Test

One-Sample Kolmogorov-Smirnov Test

		Pretes	Postes
N		32	32
Normal Parameters[a,b]	Mean	41,06	57,94
	Std. Deviation	13,317	18,739
Most Extreme Differences	Absolute	,134	,068
	Positive	,134	,068
	Negative	-,100	-,065
Test Statistic		,134	,068
Asymp. Sig. (2-tailed)		,155[c]	,200[c,d]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

Based on the information in the table, it can be concluded that the results of the normality test in relation to the pre-test question obtained sig. 0.155 > 0.05, indicating that the pre-test question is normally distributed, and the post-test question has a sig. 0.200 > 0.05, indicating that the post-test question is also normally distributed. While SPSS software version 21 was used to perform the homogeneity assumption test. The Levene Statistic test is employed in the homogeneity test. The p-value or sig. α > from = 0.05 indicates that the homogeneity criterion is satisfied. The following table shows the homogeneity results:

Table 4. Levene Statistic Test

Test of Homogeneity of Variances

Nilai

Levene Statistic	df1	df2	Sig.
3,747	1	62	,057

The t-test was employed to examine the validity of the hypothesis after acquiring data that was homogeneous and regularly distributed. The findings are shown in the table below:

Table 5. Independent Samples Test

Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pretes – Postes	-16,875	16,815	2,973	-22,938	-10,812	-5,677	31	,000

Based on the following hypothesis test:

H_0: $\mu_1 = \mu_2$: The improvement of *problem-solving* ability and *self-efficacy* that resulted from using the *problem-solving* approach of the *problem-based learning* model is the same as the *problem-solving* ability and *self-efficacy* that did not obtain the *problem-solving* approach of the *problem-based learning* model.

H_1: $\mu_1 > \mu_2$: The improvement of *problem-solving* ability and *self-efficacy* that resulted from using the *problem-solving* approach of the *problem-based learning* model is better than problem-solving ability and *self-efficacy* that did not obtain the *problem-solving* approach of *the problem-based learning* model.

The results of the mathematics tests that the students took after learning with a *problem-solving* approach model of *problem-based learning* type were superior to those of the students who took the tests before they did. H_0 is rejected because the p-value is 0.05 or less, indicating that there was a difference between the pre-test and post-test scores.

While searching related to the average score obtained by students, standard deviation, maximum score orbs, minimum score orbs, and maximum score theory, maximum score theory is then sought percentage of the questionnaire results, the affective domain on *self-efficacy* of learning results using a *problem-solving* approach with a *problem-based learning* model is carried out. According to the findings of *problem-based learning* utilizing a *problem-solving* technique, class VIII C students' *self-efficacy* is in the good category with an average score of 50.47.

4.2 Discussion

With the goal of enhancing *problem-solving* skills and *self-efficacy*, class VIII C students are learning mathematics using algebraic learning materials and a *problem-based learning* style.To develop students' *problem-solving* skills and *self-efficacy*, the goal of this study is to ascertain the impact of mathematics learning utilizing the *problem-solving* strategy of *problem-based learning* model. Students took a pre-test before learning about algebraic arithmetic operations began, and the process of applying the research was completed with a post-test. Nine multiple-choice questions and one description question with integrated *problem solving* make up the pre-test and post-test questions, which are used to determine whether there is an improvement in student accomplishment before and after learning. After the pre- and post-tests, students were given a *self-efficacy* questionnaire with 14 questions, 7 of which were positive and the other 7 were negative.

The following will be explained in relation to the outcomes of the effectiveness of the learning that has been done, namely *problem-solving* skills, based on the data evaluated. Given that the test was developed and included *problem-solving*, the questions were selected from that. From a possible score of 63, students received an average post-test score of 41.5 and a pre-test score of 34.31. This suggests that the post-test results are more favourable than the results of the pre-test. Students in class VIII-C who use the *problem-solving* strategy of the *problem-based learning* paradigm have strong *self-efficacy*, with an average score of 50.47.

Students are expected to be able to restate the previously taught principles in the mathematical solution indicator. Students can comprehend a problem, create a strategy or solution plan, conduct out *problem solving* planning, and assess how well a problem was solved. According to the analysis of the answers, Student A did not comprehend the issue, did not plan a solution, and did not complete the task in accordance with what the task required. Additionally, Student A continued to operate algebraic forms with multiplication errors.Therefore, it is incorrect to assume that fixing problems completely in the past. Then there are kids B who have a *problem-solving* understanding. Even though the problem's solution is consistent with the problem's answer, the solution has not been properly designed. Additionally, the comprehensiveness of *problem solving* has not been adequately communicated in the past.Learner C, on the other hand, has correctly planned a solution to the problem and understood it, but the solution does not answer the question. In retrospect, it seems that the totality of problem solving was not properly communicated.

5. Conclusion

There is an effect of learning mathematics using the *problem-solving* approach of *problem-based learning* to improve *problem solving* skills and there are good criteria in the *problem-solving* approach of *problem-based learning* on the affective aspects of *self-efficacy.*

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