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# Effectiveness of Jigsaw Type Cooperative Learning Model on Mathematical Problem Solving Ability Viewed from Student Learning Motivation

Rani Rahmawati[a,*], Emi Pujiastuti[a]

[a] *Mathematics Department, Universitas Negeri Semarang, Sekaran Campus, Gunungpati, Semarang, 50229, Indonesia*

* *E-mail address: rina04@students.unnes.ac.id*

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Abstract

Mathematical problem-solving skills are one of the main things in learning mathematics, and need to be developed in students. One of the learning models that is effective and considered capable of improving and improving mathematical problem-solving skills is the jigsaw-type cooperative learning model. This study aims to determine the effectiveness of the jigsaw-type cooperative learning model on mathematical problem-solving ability, analyze the influence of learning motivation on students' mathematical problem-solving ability on the jigsaw-type cooperative learning model, and describe mathematical problem-solving ability in terms of learning motivation in the jigsaw-type cooperative learning model. This study used mixed methods with sequential explanatory design. The population of this study was all grade VII students of SMP N 1 Tambakromo for the 2021/2022 School Year. This research sample was obtained using a class random technique, namely class VII C students as an experimental group and class VII A students as a control group. There were 6 qualitative subjects drawn from the experimental group, namely 2 students with high learning motivation, 2 students with moderate learning motivation, and 2 students with low learning motivation. The results showed that (1) The jigsaw-type cooperative learning model is effective on students' mathematical problem-solving abilities; (2) There was a positive influence of student learning motivation on mathematical problem-solving ability in the jigsaw-type cooperative learning model of 48.4%; and (3) students with high learning motivation have high problem-solving ability, students with moderate learning motivation have moderate problem-solving ability, while students with low learning motivation.



## 1. Introduction

Mathematics is a subject that we learn at every level of school in Indonesia. This shows how important mathematics is in the world of education, because by learning mathematics, students are expected to be able to develop the ability to think, reason, communicate ideas and be able to develop creative activities and problem solving (Panjaitan, 2018: 65). The importance of the role of mathematics also has an effect on other subjects. For example, in geography lessons, mathematics is used to determine scales and comparisons in making maps. Meanwhile, in physics and chemistry subjects, mathematics is used to facilitate the decline of formulas studied (Karim, 2011). Based on the opinions above, it can be concluded that mathematics is a subject that has a considerable role in human life, especially in the world of education so that mathematics is a subject taught from elementary school to college level to help students to have the ability to solve problems critically, meticulously, effectively, and efficiently.

Pujiastuti (2020) stated that the purpose of students learning mathematics is not just to get good grades, but students must also be able to solve mathematical problems, so that later they are able to think logically and critically in solving problems. Students' mathematical problem-solving skills can provide opportunities for students to solve the problems they face, because mathematical problem solving skills provide several strategies that can see problems from various points of view, so that the decision-making

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process can be easily carried out. Therefore, problem-solving ability is the focus of mathematics learning at all levels. This statement is in accordance with Dahar (2011:121) who states that the ability to solve problems is basically the main goal of the educational process. Similarly, the expected objectives in mathematics learning by the National Council of Teachers of Mathematics (NCTM). NCTM (2000) states that there are five basic mathematical skills that are standard, namely problem solving, reasoning and proof, communication, connetion, representation.

Suherman (2003, h. 89-92) said that problem-solving skills are part of the mathematics curriculum which is very important because in the process of learning and solving it, students may gain experience using the knowledge and skills they already have to apply to problem solving that is not routine. To be able to solve the problem, the student must indicate the data in question. By teaching problem solving students will be able to make decisions. This is in accordance with the statement that teaches problem solving to students becomes more analytical in making decisions in their lives. In other words, if the student makes a decision because the student becomes skilled on how to infer relevant information, analyze the information and realize how necessary it is to research the results obtained (Hudojo, 1988, p.119). Based on this statement, problem-solving ability is one of the important abilities and must be mastered by students, because with the problem-solving ability in students, the student can make decisions and solve the problems faced based on the knowledge and experience they have.

As for this study, the indicators of problem-solving ability are according to NCTM (2000) in (Arifin et al, 2019) namely growing new knowledge of mathematics through problem solving, deciphering mathematical problems with other contexts, using and aligning various appropriate solving steps to overcome problems, and paying attention to and reflecting on the development of mathematical problems.

Based on the results of observations made at SMP N 1 Tambakromo, researchers found that students' mathematical problem-solving ability was still low. The teacher in delivering the material is too monotonous, that is, only by the lecture method. This is because the selection of learning models is not right so that students are less active and creative in following the learning process. Therefore, a learning model is needed that encourages students to be active and creative in the problem-solving process so that students' mathematical problem-solving skills can improve. Sumartini (2016) said that in improving students' mathematical problem-solving skills, it needs to be supported by the right learning model so that learning objectives can be achieved. Based on interviews with subject-teachers at SMP N 1 Tambakromo, information was also obtained that the learning model applied by mathematics teachers in learning activities still uses conventional learning models that do not actively involve students in learning activities, students are not required to think critically to express their opinions and ideas and ideas. There are various learning models that can be used in mathematics learning to improve students' mathematical problem-solving skills. One of the learning models that is thought to improve students' mathematical problem-solving skills is the cooperative learning model. As Slavin said in Isjoni (2009, p.15) that "Cooperative learning is a learning model with a learning system and working in small groups of 4-6 people collaboratively so as to stimulate students to be more passionate about learning." There are several types of cooperative learning models that can be developed in mathematics learning, one of which is the jigsaw-type learning model. This learning model causes students to be less active in discussing with other students. In line with Lie (2002:37) states that jigsaws are designed to increase students' sense of responsibility towards their own learning and the learning of others. The jigsaw-type cooperative learning model was chosen because this learning process occurs in small groups that allow students to convey what they think so that there can be discussions between students. This is in line with Lubis (2016) there are five characteristics of jigsaw-type cooperative learning, namely: listening, speaking student, cooperation, reflection of thinking and creative thinking. Based on observations at SMP N 1 Tambakromo that students are less active and easily bored when learning mathematics. This can be corrected by applying the characteristics of jigsaw-type cooperative learning.

The jigsaw-type cooperative learning model is a learning model that is divided into an origin team and an expert team to complete academic tasks through seven stages, namely determining the group of origin, providing material, determining the expert group, discussing the material, returning to the original group, the expert team presenting the results of the discussion, evaluation. One of the virtues of the jigsaw-type cooperative learning model is that this type of learning really attracts students' attention to learn more actively (Siregar et al, 2020). This is in line with Isjoni (2009) that jigsaw-type cooperative learning is a type of cooperative learner that encourages students to be active and help each other in mastering the subject matter to achieve maximum achievement. In addition, this type of learning model can increase the enthusiasm for learning for students to achieve maximum results.

Generating student learning motivation so that they are not easily bored or lazy to participate in learning is not easy for teachers. Low learning motivation is actually caused by various things, one of which is an obstacle that resides in the student himself (Syahrir: 2012). For this reason, how to generate the necessary learning motivation in a practice by carrying out certain activities. It is not uncommon when students are motivated to do an act but they do not know how to do it, cannot use existing facilities and infrastructure, or do not arrange activities in a learning process, so it is not done. High learning motivation is dashed because when trying to start learning, one must experience difficulties that should not occur.

Mathematics learning that leads students to compete in a healthy academic atmosphere in small groups that exchange ideas, motivates group members, students can build structures to accommodate new knowledge and students are seen to be active in the learning process in the classroom. Slavin (2005 : 17) explains cooperative learning on motivation theory emphasizing on the degree of change cooperative objectives change intensively for students to perform academic tasks, cognitive theory emphasizes on the influence of cooperation itself (whether the group tries to achieve group goals or not). Through cooperative learning, it is hoped that in the classroom students can be active individually, actively discuss, dare to convey ideas and accept ideas from others, creatively find solutions to a problem faced and have high confidence in learning mathematics, namely with jigsaw-type cooperative learning.

Based on the explanation above, the researcher wants to submit a study that aims to determine the effectiveness of the jigsaw-type cooperative learning model on mathematical problem-solving ability, analyze the influence of learning motivation on students' mathematical problem-solving ability on the jigsaw-type cooperative learning model, and describe mathematical problem-solving ability in terms of learning motivation in the jigsaw-type cooperative learning model.

## 2. Methods

The research method used in this study was a mixed method with a sequential explanatory research design. In this design, quantitative data collection and analysis was carried out first which was then followed by qualitative data collection and analysis to strengthen quantitative research data in the first stage (Lestari, 2017: 155). The quantitative research design used in this study was a quasi experimental form of posttest-only control design where in this design there where two groups taken randomly where the first group was given treatment (experimental group) and the other group was not (control group), then the two groups were given a post-test (Sugiyono, 2016: 112).

This research was conducted from November to December 2021. The population in this study was all grade VII students of SMP Negeri 1 Tambakromo for the 2021/2022 School Year. In this study, sampling was carried out using a class random method and two samples were obtained, namely class VII C as the experimental class and class VII A as the control class. The experimental class acquires learning with a jigsaw-type cooperative model while the control class acquires learning with a conventional model or direct learning commonly applied to samples. The subjects in this study were six grade VII C students selected by purposive sampling technique.

Quantitative research methods were used to test students' mathematical problem-solving ability on jigsaw-type cooperative learning models whether they achieve classical completeness and analyze whether the average and proportion of students' mathematical connection ability completion in jigsaw-type cooperative learning models are better than students on conventional learning models. Meanwhile, qualitative methods in this study were used to describe mathematical problem-solving abilities in terms of student learning motivation in jigsaw-type cooperative learners.

The variables of this study were mathematical problem-solving ability and student learning motivation. The data collection methods used are test methods, mathematical resilience questionnaires, and interviews. The test method was used to collect mathematical connection ability data after mathematical learning with jigsaw-type cooperative models and conventional learning. The questionnaire method was used to measure the mathematical resilience ability of experimental class students which was then used to group students into high, medium, and low groups. The interview method in this study was conducted unstructured to obtain a description of the ability of mathematical connections in terms of students' mathematical resilience.

## 3. Results and Discussions

*3.1 Results and Discussion of Quantitative Data*

Before hypothesis testing is carried out, the posttest result data are first tested for normality and homogeneity. After testing normality and homogeneity in both classes, the results were obtained that the final data came from populations that were normally distributed and had the same variance (homogeneous), so that it could be continued with hypothesis testing.

The calculation of hypothesis test 1 is used to find out whether the results of the mathematical problem-solving ability test of students with a jigsaw-type cooperative learning model can achieve classical completion. The test used to test hypothesis 1 is a proportional test of one party, namely the right party. From the calculation results obtained the values of $z_{count} = 21.07$ and $z_{table} = 1.64$. Because $z_{hitung} > z_{tabel}$ maka based on the test criteria, $H_0$ is rejected. So, the proportion of students on the jigsaw-type cooperative learning model achieved classical completeness on the mathematical problem-solving ability test.

Hypothesis test 2 is used to find out whether the average mathematical problem-solving ability of students who follow jigsaw-type cooperative learning is better than the mathematical problem-solving ability of students who follow conventional learning. The test used in the classical completeness of student learning is a two-sided difference test, namely the right party. From the calculation results obtained the values of $t_{count} = 2.24$ and $t_{table} = 1.67$. Because of the calculation $t_{count} > t_{table}$, based on the test criteria, $H_0$ is rejected. So, it can be concluded that the average student's mathematical problem-solving ability in jigsaw-type cooperative learning is more than the average student's mathematical problem-solving ability in conventional model learning.

Hypothesis test 3 was carried out to analyze whether the proportion of completed students to mathematical problem-solving ability with the application of jigsaw-type cooperative learning models in the experimental group was better than the proportion of students who completed mathematical problem-solving abilities with the application of conventional learning models to control groups. The test used is a two-proportional difference test of one right party. From the calculation results obtained the values of $z_{count} = 2.93$ and $z_{table} = 1.64$. Because of the calculation $z_{count} > z_{table}$ then based on the test criteria, $H_0$ is rejected. So the proportion of completeness of mathematical problem-solving ability in jigsaw-type cooperative learning is better than the proportion of completeness of mathematical problem-solving ability in conventional learning.

Hypothesis test 4, namely a regression test, was carried out to determine the influence between student learning motivation and students' mathematical problem-solving ability on the jigsaw-type cooperative learning model in the experimental group. Before the regression test is carried out, it is necessary to test classical assumptions to obtain confidence that the data obtained along with research variables are feasible to be processed (Sabrudin & Suhendra, 2019). Classical assumption tests in research include residual normality tests, linearity tests, and heterochedasticity tests. Obtained normally constructed residual data, there is a linear relationship between learning motivation and mathematical problem-solving ability, and heterochedasticity does not occur. Furthermore, the regression test obtained the value of Sig.=0.000<0.05, so it can be concluded that learning motivation affects students' mathematical problem-solving ability in the jigsaw-type cooperative model. Based on the Model Summary table, the relationship between learning motivation and mathematical problem-solving ability has a contribution of 48,4% to students' mathematical problem-solving ability and the remaining 51.6% is influenced by other factors beyond learning motivation.

In general the formula of a simple linear regression equation is $Y = a + bX$. The value of a can be seen in the Coefficients table obtained a constant value of $-9.822$, this number is a constant number which means that if there is no motivation to learn then the value of mathematical problem-solving ability is $-9.822$. Then the regression coefficient figure is obtained by $0.793$. This number means that every addition of 1% of the level of learning motivation, the student's mathematical problem-solving ability will increase by $0.793$. Since the value of the regression coefficient is positive $(+)$, it can thus be said that students' learning motivation has a positive effect on mathematical problem-solving ability. So the regression equation is $Y = -9.822 + 0.793X$.

Referring to the discussion above, we can conclude that learning motivation has a positive effect on students' mathematical problem-solving ability with a total influence of 48.4%. This positive influence means that the increasing learning motivation of students will affect the improvement of students' mathematical problem-solving abilities.

The jigsaw-type cooperative learning model is a group learning model that is divided into two, namely the origin group and the expert group. Jigsaw-type cooperative learning can improve students' mathematical problem-solving skills to be higher. This is in line with the results of research from Oktavien, et al (2012) showing that students who obtained jigsaw-type cooperative learning in general showed improved learning outcomes better than conventional learning. In addition, the results of research from Asri (2016) stated that improving the mathematical problem-solving ability of students who obtained jigsaw-type cooperative learning was better than the mathematical problem solving ability of students with ordinary (conventional) learning.

*3.2 Qualitative Results and Discussion*

*3.2.1 Selection of Research Subjects*

After the mathematical problem-solving ability test result data is obtained, the data is then analyzed by researchers and grouped based on the category of student learning motivation. Based on the calculation of the Likert scale of the student learning motivation questionnaire, out of 31 students in class VII C, there were 14 students in the high category, 15 students in the medium category, and 2 students in the low category. The diagram of the distribution of student learning motivation can be seen in Figure 1 below.

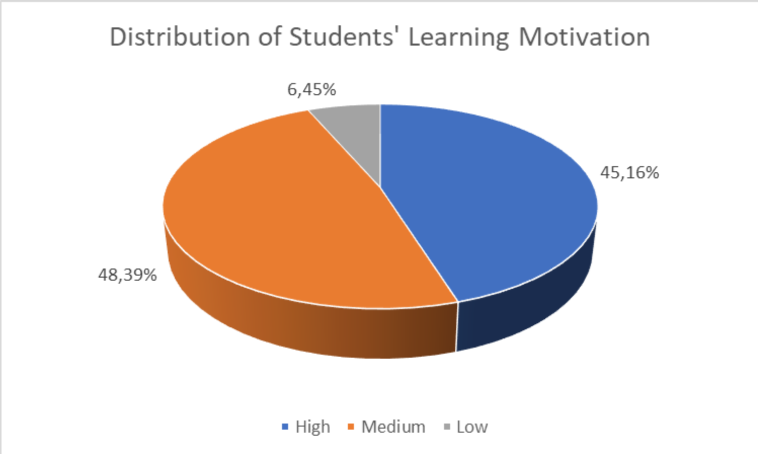


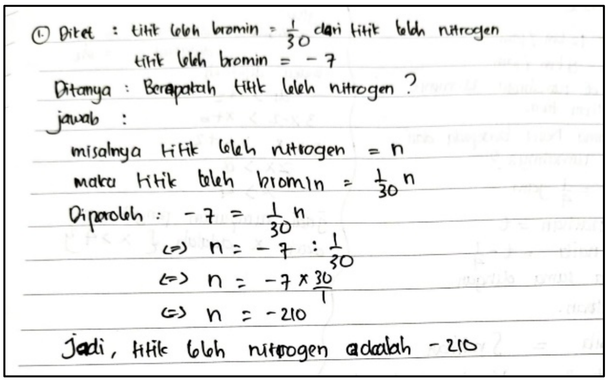

**Figure 1. Diagram of the Distribution of Learning Motivation of Experimental Class Students**

From these results, 2 research subjects were taken each representing each category of student learning motivation so that 6 research subjects were obtained. Researchers' considerations in choosing research subjects to interview are based on how students answer when given questions about the results of their work, the results of the learning motivation questionnaire, and the results of mathematical problem-solving ability tests.

This study uses four indicators of problem-solving ability according to NCTM (2000) in (Arifin et al, 2019) namely 1) fostering new knowledge of mathematics through problem solving, 2) deciphering mathematical problems with other contexts, 3) using and harmonizing various appropriate solving steps to overcome problems, and 4) paying attention to and reflecting on the development of mathematical problems. The six subjects that have been selected are then interviewed to ensure that the data obtained are valid. Interviews were conducted based on the final data of mathematical problem-solving ability given after the experimental class received treatment.

*3.2.2 Mathematical Problem Solving Ability Reviewed from Student Learning Motivation*

The research subjects solved five questions with each question all indicators of mathematical problem-solving ability. The validity of qualitative data is carried out by triangulating techniques between the analysis of the results of the mathematical problem-solving ability test work and the analysis of the results of student interviews. The analysis of this mathematical problem-solving ability starts from the first indicator to the last indicator, starting from question number 1, number 2, number 3, to number 5. The following is one of the results of the work of subjects with a high learning motivation category T1 (E-03) on question number 1.



① Diket : titik leleh bromin = $\frac{1}{30}$ dari titik leleh nitrogen
titik leleh bromin = − 7
Ditanya : Berapakah titik leleh nitrogen ?
jawab :
misalnya titik leleh nitrogen = n
maka titik leleh bromin = $\frac{1}{30}$ n
Diperoleh : $-7 = \frac{1}{30}n$
$\Leftrightarrow n = -7 : \frac{1}{30}$
$\Leftrightarrow n = -7 \times \frac{30}{1}$
$\Leftrightarrow n = -210$
Jadi, titik leleh nitrogen adalah −210

**Figure 2.** Results of T1 Work Question Number 1

Based on the results of the T1 written test in question number 1, it can be seen that T1 can meet four indicators of problem-solving ability. The first indicator of cultivating new knowledge of mathematics through problem solving is shown by T1 being able to write down and express what is known and asked, as well as the scope of the necessary elements of the problem being proposed clearly using one's own sentences. The second indicator, which is to describe mathematical problems with other contexts, is shown by T1 being able to make plans or strategies to solve problems, which can be shown by T1 outlining mathematical problems in other contexts in the form of mathematical sentences. Then the third indicator of using and aligning various appropriate resolution steps to solve the problem can be seen T1 implementing the plan that has been made, using the steps to solve the problem correctly, no procedure errors occurred, and no calculation algorithm errors occurred. The fourth indicator is to pay attention to and reflect on the development of mathematical problems T1 writing conclusions with the answers written is also in accordance with what is asked in the question and is of correct value.

Based on the data from the analysis results of each research subject, students with high learning motivation, namely T1 (E-03) and T2 (E-24), respectively have high and high mathematical problem-solving abilities. Students with high mathematical resilience T1 are able to answer all questions with 3 questions answered correctly while T2 is able to answer all questions correctly and is able to meet all indicators of mathematical connection ability well. Subject T1 is able to meet the indicator of connecting between topics in mathematics and the indicator of connecting mathematical concepts with other fields of science, is quite able to meet the indicator of linking mathematical concepts and procedures in a mathematical topic, but is not able to meet the indicator of linking mathematical concepts with everyday life. After further exploration, subject T1 explained the step of solving number 3b well but there were calculations that were not written on the answer sheet. In addition, subject T1 admitted that he did not understand the steps to solve question number 2b. Based on the results of the confirmation of the question items on the student's mathematical resilience questionnaire, it is known that the two subjects, T1 and T2, wrote down the answers consistently, so it can be said that they have answered the questions in the questionnaire honestly.

Furthermore, based on data from each research subject, students with high learning motivation, namely T1 and T2, have high problem-solving abilities. Students in high groups can answer 5 questions provided and 5 questions answered correctly. The results of the qualitative analysis of students' problem-solving abilities in the high learning motivation group found that subject T1 and subject T2 were able to meet all indicators of mathematical problem-solving ability, namely growing new knowledge of mathematics through problem solving, deciphering mathematical problems with other contexts, using and aligning various appropriate solving steps to overcome problems, and paying attention to and reflecting on the development of problems mathematics.

From the data from the results of each research subject with moderate learning motivation, namely S1 and S2 subjects have moderate problem-solving skills. Subject S1 can answer all questions with 3 questions answered correctly while subject S2 can answer all questions with 3 questions answered correctly. Subject S1 meets all the indicators of mathematical problem-solving ability in question items number 3, 4, 5. As for number 1, it only meets two indicators, namely growing new knowledge of mathematics through problem solving and deciphering mathematical problems with other contexts. Then for question item number 2, it can only meet three indicators, namely outlining mathematical problems with other contexts, using and aligning various appropriate solving steps to solve problems, and paying attention to and reflecting on the development of mathematical problems. Subject S2 meets all the indicators of mathematical problem-solving ability in question items number 2, 4 and 5. As for number 1, S2 can only meet one indicator, namely using and aligning various appropriate solving steps to solve problems, and in question point number 3, S2 can only meet one indicator, namely cultivating new knowledge of mathematics through problem solving.

As for students with low learning motivation in the low category, the subjects R1 and R2 have low problem-solving ability. Subject R1 can only do one question correctly, while for the other questions it only meets one indicator. R1 can meet one indicator of problem-solving ability in question items number 1, 2, 3, and 4, namely fostering new knowledge of mathematics through problem solving. For question item number 5, subject R1 can meet all indicators of mathematical problem-solving ability. Furthermore, for the subject R2, it can only do two questions and meet four indicators perfectly, namely in question items number 1 and 5. As for question items number 2, 3, 4 so that it can be said that R2 can only provide one indicator, namely growing new knowledge of mathematics through problem solving.

## 4. Conclusions

The results of this study show that (1) The jigsaw-type cooperative learning model is effective on students' mathematical problem-solving abilities; (2) There was a positive influence of student learning motivation on mathematical problem-solving ability in the jigsaw-type cooperative learning model of 48.4%; and (3) students with high learning motivation have high problem-solving ability, students with moderate learning motivation have moderate problem-solving ability, while students with low learning motivation.

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