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# JUCAMA learning model: A pathway to improved mathematical communication

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**Abstract**
Mathematical communication is a fundamental competence that enables students to express, interpret, and justify mathematical ideas clearly; however, many junior high school students still demonstrate low proficiency in this skill. This study examines the effect of the Problem Submission and Solving (JUCAMA) learning model on students' mathematical communication abilities at MTsS Darul Mukhlisin Takengon, emphasizing its role in fostering critical and logical thinking in mathematics education. A quasi-experimental posttest-only control design was employed with a total sample of 53 eighth-grade students, randomly selected from two classes: Class VIII.C as the experimental group (28 students) and Class VIII.D as the control group (25 students). Data were collected through tests and observations and analyzed using a t-test. The results show that the experimental group achieved a significantly higher mean score (49.46) than the control group (25.8). Statistical analysis confirmed this difference ($t = 37.14 > t\_table = 2.01$), indicating a substantial effect of the JUCAMA learning model. Practically, these findings suggest that the JUCAMA model can be adopted by mathematics teachers to encourage active participation and strengthen students' reasoning and communication skills. Future research may examine this model in other mathematical competencies and explore technology integration to enhance engagement.

**Keywords:** Mathematical communication abilities, Mathematical education, Problem solving, Problem submission, Problem submission and solving (JUCAMA)

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## Introduction

Mathematics education plays a crucial role in developing students' logical, critical, and creative thinking, as well as their ability to communicate ideas effectively. Mathematics is not only applied in academic contexts but also in everyday life, such as in trade and financial transactions, problem-solving, and decision-making processes (Palinussa et al., 2021). For this reason, mathematics learning in schools must aim not only to transfer knowledge but also to cultivate students' capacity to reason and communicate mathematically.

One essential aspect of mathematics learning is mathematical communication. Mathematical communication refers to students' ability to express mathematical ideas using symbols, language, diagrams, or models, both orally and in writing (Kamid et al., 2020). Strengthening this skill allows students to organize their mathematical reasoning, articulate arguments, and engage in meaningful classroom discussions. However, observations in MTsS Darul Mukhlisin Takengon revealed that many students struggle with mathematical communication. They often fail to identify known and unknown information in problem statements, have difficulty translating problems into mathematical representations, and are unable to draw conclusions from their solutions. These weaknesses highlight the need for teaching models that directly support communication skills.

The learning element is a significant determinant that influences students' mathematical communication. Consequently, to improve students' mathematical communication abilities, it is essential to choose learning practices that promote active participation, facilitate conversations, and enable the articulation of their reasoning (Musdi et al., 2024). Discussions encourage active engagement among students, improving their mathematical communication abilities through interactions with peers and the teacher (Ahdhinato et al., 2019).

The success of a student in learning mathematics is dependent on their cognitive abilities and proficiency in mathematical communication. Likewise, an educator must select a pedagogical technique that aligns with the subject content and the students' real-world setting (Ramadhani et al., 2021). The new educational paradigm emphasizes that learners have primary agency in activities, while teachers serve as facilitators who assist students in self-constructing knowledge (Aulia et al., 2020). Therefore, it is essential to select a method that fosters and promotes active student engagement in learning, thereby enhancing students' mathematical communication abilities.

Mathematical communication abilities significantly impact learning, as they embody a kind of student interaction within the mathematical domain that transpires in the classroom (Daulay, 2019). The mathematical interactions among students, between students and teachers, and between students and books will significantly impact the enhancement of their comprehension skills (Uyen et al., 2021). Improving student quality involves not only advanced cognitive skills but also effective communication, which will profoundly influence their perspective.

The observation using a mathematical communication test at MTsS Darul Mukhlisin Takengon showed mistakes because: 1) students didn't understand the problems, which made it harder for them to turn those ideas into variables; 2) students didn't separate the known information and the questions before solving the problem, which made the resolution process more difficult; and 3) students couldn't draw conclusions from the solutions they had come up with. The findings indicate that the kids' communication abilities are deficient.

As a result, the relevant issue is the instructional model employed by the educator; therefore, the educator must identify a teaching model that can be refined to improve students' mathematical communication abilities. The researcher aims to employ the Problem Submission and Solving model (JUCAMA) to enhance students' comprehension of the learning process (Prihatiningtyas & Rosmaiyadi, 2020).

The problem submission and solving learning model in mathematics emphasizes the presentation and resolution of mathematical problems as the central component of the educational process (Fajrizal et al., 2019). It emphasizes active cognitive involvement to enhance children's creative thinking abilities. This technique requires students to articulate their view points through problem-presenting and resolve issues through problem-solving, enhancing their creative thinking skills.

The Problem Submission and Solving (JUCAMA) learning model is an innovative approach that integrates submitting and solving problems as core elements in mathematics learning. This model is designed to actively engage students in analyzing, formulating, and solving problems through meaningful interactions with subject matter, peers, and teachers. Although it has great potential to improve students' mathematical communication and critical thinking skills, implementing JUCAMA is still limited at several levels of education, including Madrasah Tsanawiyah (MTs) or schools with unique challenges.

Educational environments such as MTs often face specific obstacles, such as limited learning facilities, lack of teacher training on innovative learning methods, and diverse student abilities that are not evenly distributed. This implements the JUCAMA model in MTs, a challenge requiring an adaptive approach. Previous research has shown that this model is effective in secondary schools in improving students' creative thinking skills in geometry material and training them to convey mathematical ideas in writing and orally (Heriyanto et al., 2021; Wardani et al., 2021). However, the application of JUCAMA at educational levels, such as MTs, which have characteristics of students with low active involvement and limited experience in solving mathematical problems, is still relatively rarely explored in the literature (Lutfia et al., 2023; Umar, 2019).

Although previous studies have demonstrated the effectiveness of the JUCAMA learning model in enhancing students' creative thinking and problem-solving skills at the secondary school level, its application in Madrasah Tsanawiyah (MTs) remains underexplored. This context presents unique challenges, including limited learning facilities, uneven student abilities, and a lack of teacher training in innovative pedagogies. Furthermore, most prior research has emphasized creative or critical thinking, while relatively little attention has been given to students' mathematical communication skills. Therefore, this study provides a novel contribution by investigating the implementation of the JUCAMA model in the MTs context, specifically focusing on improving mathematical communication abilities. The findings are expected to broaden the application of JUCAMA and offer practical insights for mathematics teachers working in similar educational environments.

## Methods

This research is a quasi-experimental study, employing a posttest-only control group design. This design was chosen because it minimizes the risk of pretest sensitization that could influence students' learning outcomes. By focusing solely on the posttest, the study aimed to obtain a more accurate measure of the learning model's effect without interference from prior exposure.

The study population included all eighth-grade students of MTsS Darul Mukhlisin Takengon, which consisted of four classes with a total of 119 students. Random sampling was conducted at the class level rather than at the individual level. From the four existing classes, two were randomly selected, with class VIII.C (28 students) assigned as the experimental group and class VIII.D (25 students) as the control group. The experimental group was taught using the Problem Submission and Solving (JUCAMA) learning model, while the control group received direct instruction.

The instruments used in this study consisted of an observation sheet and a mathematical communication test. The observation sheet measured students' engagement during instruction, including their participation in discussions, responsiveness to teacher questions, and ability to express mathematical ideas both orally and in writing. The mathematical communication test, which comprised six open-ended questions, was designed to evaluate students' skills inrepresenting mathematical ideas through language, symbols, and diagrams. The validity of both instruments was confirmed through expert judgment by mathematics education lecturers, and their reliability was established via a pilot test with Cronbach's Alpha coefficient exceeding 0.70, indicating acceptable reliability.

Data analysis followed several steps. First, the Kolmogorov-Smirnov test was applied to examine the normality of score distributions. Second, Levene's test was used to check the homogeneity of variances between the control and experimental groups. Since the assumptions of normality and homogeneity were met, an independent samples t-test was conducted to determine whether the JUCAMA learning model had a significant effect on students' mathematical communication skills.

## Result

According to the findings of the eighth-grade research conducted at MTsS Darul Mukhlisin Takengon, the examinations administered to the control and experimental classes were the final test (post-test). Following the teaching and learning process, the researcher administered a final evaluation to both the control and experimental classes in order to assess the students' comprehension of the system of linear equations in two variables. The control class implemented direct teaching techniques, while the experimental class implemented the problem submission and solving model.

We use the existing formulas to process the final test results from the control and experimental courses. We will illustrate the learning outcomes from the administered tests in the subsequent tables. For clarification, please refer to the completion Table 1.

### Results of the Final Test for Experimental and Control Classes

Table 1 indicates that the experimental group has 28 samples, whereas the control group contains 25 students. The average value for the experimental group is 49.46, whereas for the control group it is 25.8. The standard deviation for the experimental group is 1.48, whereas it is 7.28 for the control group. The variance in the experimental group is 7.26, whereas in the control group it is 4.70. The maximum score in the experimental class is 57, whereas in the control class it is 38. The minimum score in the experimental class is 35, whereas in the control class it is 11.

**Table 1.** Results of Score Data Management Final Tests of the Experimental Class and the Control Class

| | Experiment | Control |
|---|---|---|
| N (sample) | 28 | 25 |
| Mean | 49,46 | 25,8 |
| Standard Deviation (S) | 1,48 | 7,28 |
| Variants ( $S^2$) | 7,26 | 4,70 |
| Highest score | 57 | 38 |
| Lowest score | 35 | 11 |

## Assessment of Normality

The researchers administered a normalcy test after completing the final assessments on each sample class. Conduct a normalcy test utilizing SPSS Version 21. The criteria for the normality test stipulate that a significance value beyond 0.05 indicates normally distributed residuals, whereas a significance value below 0.05 signifies non-normally distributed residues.

For more elucidation, we might examine the SPSS output presented in Table 2.

**Table 2**. Tests of Normality

| | | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|---|
| | Class | Statistic | Df | Sig. | Statistic | df | Sig. |
| Mathematical Communication | Experiment | .159 | 28 | .167 | .904 | 28 | .114 |
| | Control | .096 | 25 | .200* | .962 | 25 | .450 |

The normality test results in Table 2 indicate that the significant values for the experimental class are 0.167 and 0.114, while for the control class, they are 0.200 and 0.450, all over 0.05. Therefore, we can deduce that the significance values follow a normal distribution.

## Test for Homogeneity

A significance threshold of $\alpha = 0.05$ is employed to conduct the homogeneity test using Bartlett's examination. The evaluation criteria are as follows: the variances are homogeneous if F calculated is less than F table; the variances are not homogeneous if F calculated is greater than or equal to F table; and the variances are homogeneous if F calculated is less than or equal to F table.

The concluding test computations in the control and experimental groups produced a derived value of F_calculated = 1.24 and F_table = 3.841, indicating that the variance is homogeneous. Table 3 summarizes the homogeneity test results as administered by SPSS Version 21.

**Table 3.** Test of Homogeneity of Variances

| Levene Statistic | | df1 | df2 |
|---|---|---|---|
| 4.754 | 1 | 51 | Sig. |

The decision criteria are as follows: a significance value above 0.05 indicates homogeneous data distribution, whereas a significance value below 0.05 indicates non-homogeneous data distribution. Thus, as demonstrated by the findings in Table 3, the significance value surpasses 0.05, enabling us to infer that the residual values are uniformly distributed.

### Hypothesis Testing

The results of the normality and homogeneity tests indicate that the samples originate from regularly distributed and homogenous data. As a result, the data will be subjected to hypothesis testing. We conducted a hypothesis test using the t-test statistic to evaluate how the Problem Submission and Solving (JUCAMA) learning model affected students' mathematics communication skills.

**Table 4.** Results of Hypothesis Testing Data Management

| Testing Criteria | $T_{test}$ | $T_{table}$ | Description |
|---|---|---|---|
| If $t_{calculated} > t_{table}$ then $H_a$ is accepted<br>If the calculated t is greater than the t table, then the alternative hypothesis is accepted<br>If $t_{calculated} < t_{table}$ then $H_0$ is accepted<br>If the calculated value is less than the table value, then $H_0$ is accepted. | 37,1428 > 2,007584 | | $H_a$ accepted. |

The conclusion is accepted, as the t-test calculation in Table 4 above produced a result of t calculated > t table, or 37.14 > 2.01. The introduction of the Problem Submission and Solving learning model significantly influences students' mathematical communication abilities.

## Discussion

After engaging in a conversation with the eighth-grade mathematics instructor, the researcher selected samples from a variety of eighth-grade courses. As the experimental group, the researcher randomly selected class VIII.C, while class VIII.D was designated as the control group. This study assesses students' mathematics communication abilities through the following indicators: (1) Utilizing actual objects, images, graphs, and algebra, clarifying mathematical relationships, situations, and ideas in both written and spoken communication; (2) Communicating daily events in mathematical language or symbols, both orally and in writing; (3) Students possess the ability to utilize language, mathematical symbols, and their structures to express ideas and define connections using situational models. When comparing the experimental class to the control class, researchers have identified numerous factors that contribute to the former's superior mathematical abilities.

The author will present the analytical results in this paper, which include the students' mathematical communication skills and the learning processes that occur in the control and experimental groups.

### The Problem Submission and Solving Learning Model Is Implemented

The Problem Submission and Solving learning model emphasizes the importance of asking questions to gauge students' understanding of the material they are learning. These inquiries aim to improve students' mathematical communication abilities. Furthermore, engaging with these issues will enhance students' experience in resolving mathematical problems; thus, familiarity with problem-solving will lead to greater proficiency in mathematical communication (Umar, 2019).

The experimental group implements the Problem Submission and Solving learning model. The integration of this learning involves the use of learning activity sheets, which are utilized to pose questions, thereby enhancing the efficiency of the learning process (Evendi et al., 2022). The lesson plan guides the implementation of the learning activities. After the teacher presents the curriculum and provides example problems relevant to the topic, students form multiple teams to evaluate their mathematical communication skills through the completion of various questions provided by the learning activity sheets (Rahmaini et al., 2024).

The teacher encountered numerous challenges during the initial meeting, including pupils who were not yet engaged in responding to the teacher's inquiries and a teacher of ours needs regular training and development, as well as updates on teacher technology competencies and pedagogical and methodological strategies in the classroom (Hossein-Mohand et al., 2021). Additionally, the students were unable to resolve the presented issues, and during the discussion activities, a significant number either worked independently or solely relied on their group members to complete the tasks (Wardani et al., 2021).

This is due to the students' lack of familiarity with the researchers' learning paradigm, which requires them to adapt. Students are typically capable of addressing the issue directly without the need to follow the traditional stages of identifying the problem and developing a solution plan once they have a clear understanding of the information and the questions being asked (Lutfia et al., 2023).

Numerous students' incorrect answers were a result of incomplete work stages. Some students rushed or left out certain steps, leading to incorrect answers (Syamsuddin et al., 2020). After the queries were completed, the teacher requested that the students submit their responses for review. The teacher then asked one of the groups to come forward and write on the board, explaining the presented problem. After the students had completed their work, the teacher facilitated the discussion by providing the correct answers to the problems and subsequently asking about the students' comprehension. If they do so, the instructor will evaluate the pupils' comprehension of the provided questions.

Nevertheless, the teacher did not achieve the desired optimal results in mathematical communication skills during the initial meeting, as numerous students were still unable to solve the problems (Daulay et al., 2017). The teacher concluded the lesson by reflecting on the learning activities and assigning homework that included questions relevant to the day's learning material.

During the second meeting, the researchers aimed to improve the activities they had not executed effectively during the first meeting. The teacher, who facilitates the discussion, encourages students to participate more actively in responding to the instructor's inquiries. Additionally, the teacher informs students that the discussion results will be evaluated by arbitrarily selecting pupils rather than by group representatives in order to increase student engagement in groups.

Consequently, in order to facilitate students' comprehension, educators should implement more structured and effective problem-solving steps. Subsequently, they can derive conclusions from the presented issues (Szabo et al., 2020). The students' mathematical communication skills in this second meeting have improved relative to the first meeting; yet, they have yet to fulfill the anticipated criteria (Klochkova et al., 2016). The instructor concluded the session by assigning exercises that were relevant to today's material as homework.

The researcher effectively executed nearly all activities included in the lesson plan during the third meeting. The students successfully implemented the methods to resolve mathematical communication issues and collaborated with their peers to achieve favorable outcomes. The researchers reiterated the concerns inherent in learning activity sheets during the fourth conference, which was similar to the last meeting. During the fourth meeting, the kids had already fulfilled the anticipated criteria. The instructor closed the course with a reflection and announced that the subsequent meeting will entail an exam.

## The Proficiency of Students in Communicating Mathematical Concepts

The mathematical communication skills of the students discussed in this study pertain specifically to their written mathematical communication abilities. This document will offer various final test responses submitted by students from both the experimental and control groups. Articulating concepts, circumstances, and mathematical relationships in written form through tangible things, images, graphs, and algebra encompasses students' capacity to derive solutions by employing concepts and scenarios from daily life. Number 1 is one of the instruments used to quantify this attribute.

This is an instance of a question and response from a student in the experimental class.

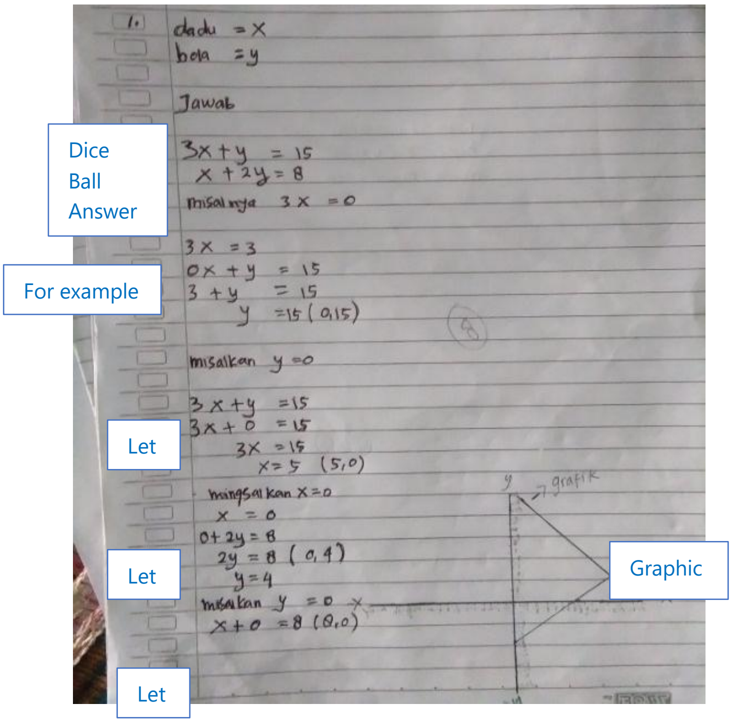


**Figure 1.** Sample of a Student's Final Test Answer from the Experimental Class

Figure 1 illustrates a student's written response from the experimental group, demonstrating the ability to articulate mathematical situations through symbols, equations, and graphical representations. The problem context involves Fitri obtaining 15 points from three dice rolls and one ball throw, while Ika obtains 8 points from one dice roll and two ball throws. The student successfully translates the contextual situation into a system of linear equations, applies algebraic procedures, and represents the solution graphically. This indicates that students in the experimental group are able to communicate mathematical ideas clearly and logically, supporting the effectiveness of the JUCAMA learning model in developing mathematical communication skills.

We present the responses from the students in the control class here.

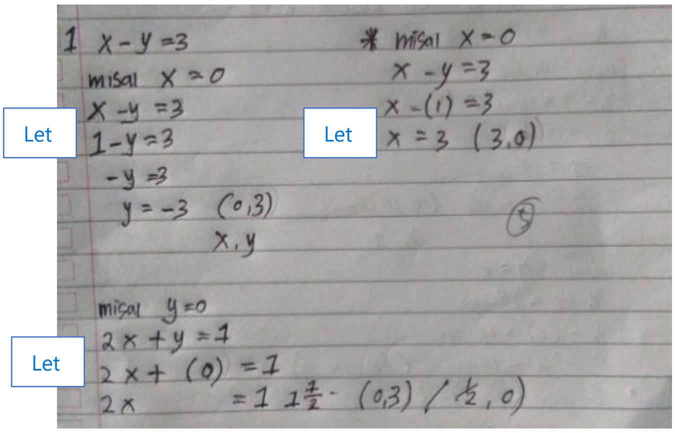


**Figure 2**. Sample of a Student's Final Test Answer from the Control Class

Figure 2 indicates that students in the control class have not yet fully cultivated their mathematical communication skills in articulating ordinary events using concepts and scenarios. Their failure to adhere to the necessary procedures in their work renders the issues difficult to comprehend; the explanations offered by the students do not correspond with the content about systems of linear equations in two variables presented in the questions.

This mathematical communication indicator encompasses pupils' capacity to articulate ordinary occurrences using mathematical language or symbols in written form. Instrument number 2 measures this indicator. This is an instance of a question and a student's response in the experimental class.

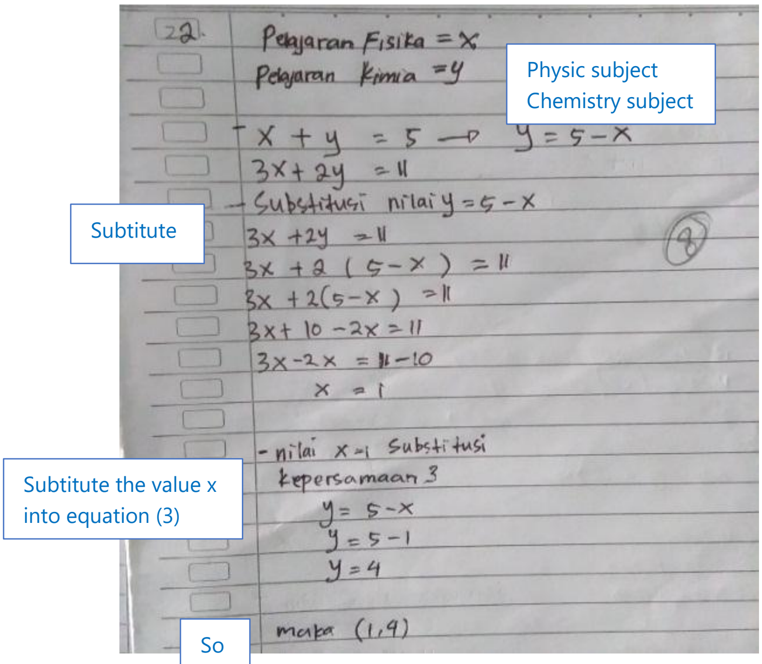


**Figure 3**. Sample of a Student's Final Test Answer from the Experimental Class

According to Figure 3, prior to addressing the questions, students must articulate daily occurrences using mathematical language or symbols in written form. Let X denote Andi's score on the physics test and Y denote Tomi's score on the chemistry test, with respective scores of 5 and 11. After completing the preliminary procedures, students easily create equations, which allows them to perform algebraic computations efficiently and draw sound conclusions. The responses of the pupils in Figure 3 demonstrate a significant improvement in the mathematics communication skills of the experimental class. Students have successfully articulated daily occurrences using mathematical symbols.

An example of a student's response in the control class is shown in Figure 4.

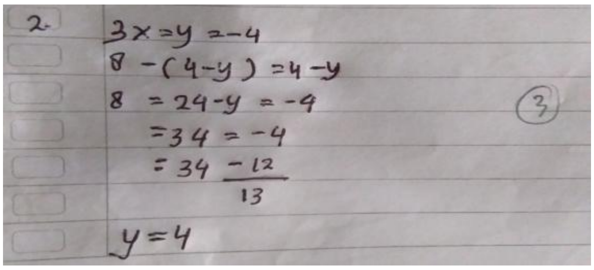


**Figure 4**. Sample of a Student's Final Test Answer from the Control Class

Figure 4 shows that the control class pupils can already articulate daily occurrences in written form using mathematical language or symbols. Similar to X and Y, as illustrated in Figure 4, students promptly respond to the inadequately formulated questions, omitting several first stages, which complicates their approach and hinders their ability to reach conclusions.

This indicator encompasses students' proficiency in employing mathematical terminology, notations, and frameworks to articulate concepts and delineate relationships within situational models. Question number 6 is one of the instruments that assesses this indicator. This is an illustration of a question and its corresponding response in the experimental class.

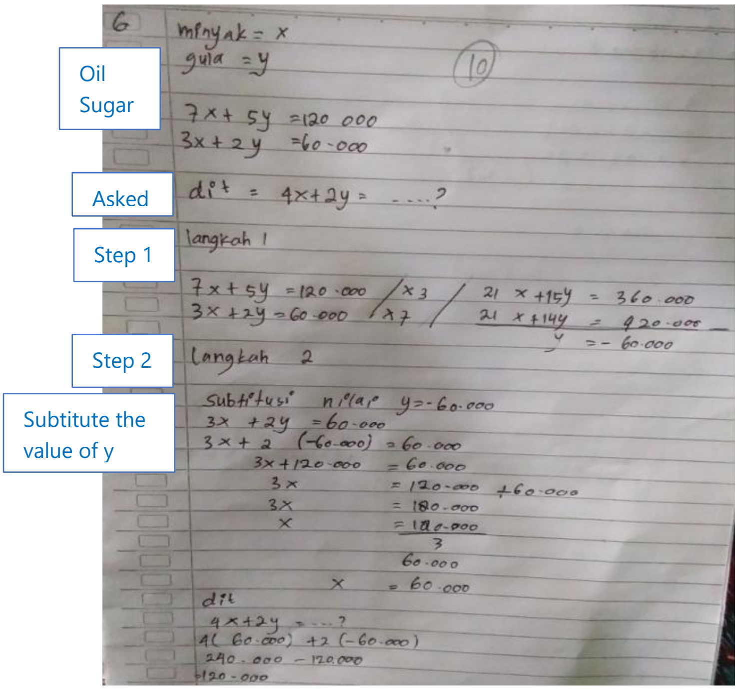


**Figure 5**. Sample of a Student's Final Test Answer from the Expereimental Class

Figure 5 illustrates that students can employ mathematical terminology and notations to engage with situational models. Prior to responding to the questions, students must possess the ability to utilize mathematical terminology and symbols. Similar to how X procures cooking necessities for Mrs. Tika and Y for Mrs. Rani, pupils will be capable of articulating concepts in an organized format once they have mastered terminology and notation. Mrs. Tika purchased 7 kg of oil and 5 kg of sugar for Rp 120,000, but Mrs. Rani acquired 3 kg of oil and 2 kg of sugar for Rp 60,000.

The students then depict the relevant links based on Mrs. Tika and Mrs. Rani's concerns, enabling them to address future difficulties through mathematical models. Following the appropriate procedures, the pupils can execute the algebraic computations comprehensively and precisely.

An instance of student work from the control group is as Figure 6.

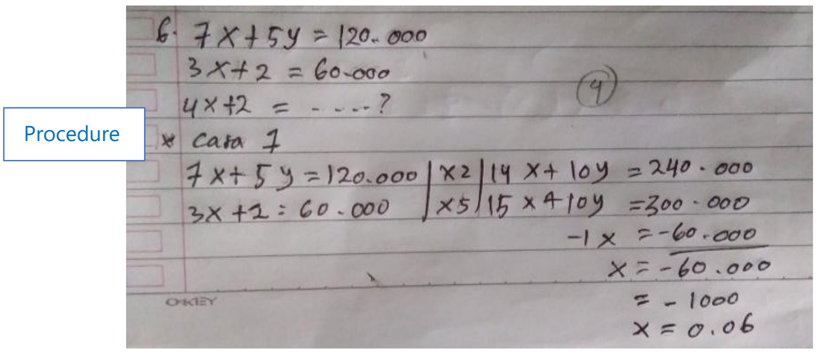


**Figure 6**. Sample of a Student's Final Test Answer from the Control Class

The control class students' responses in Figure 6 indicate that this aspect remains unsatisfactorily addressed. Despite the fact that students are capable of employing mathematical terms and notation, they are still unable to comprehend mathematical models.

As a result, it is difficult to establish a connection between Mrs. Tika's purchase of 7 kg of oil and 5 kg of sugar for Rp120,000 and Mrs. Rani's purchase of 3 kg of oil and 2 kg of sugar for Rp60,000. Therefore, when students do not grasp how to solve it, they cannot draw algebraic inferences accurately and appropriately.

Based on the description provided, it can be inferred that students taught utilizing the Problem Submission and Solving learning model have higher mathematical communication abilities compared to students taught through standard learning techniques (Suji et al., 2023). The relationship between the Problem Submission and Solving learning model and students' mathematical communication abilities is that the Problem Submission and Solving model is oriented towards the Problem Submission and Solving of mathematical issues, acting as the center of learning and promoting active mental engagement (Utari et al., 2020). This can increase students' mathematical communication skills, as communication provides an opportunity for students to engage in thinking, discussion, and communication to arrive at accurate solutions to the difficulties they confront (Putri & Musdi, 2020).

When addressing problems, students are given the opportunity to comment and address impediments when an answer technique has not yet been established. At that moment, pupils must be able to understand the visuals, graphs, symbols, and mathematical ideas presented by the teacher in order to correctly get the steps for the solutions given (Novianti & Khoirotunnisa, 2016). After the conversation is concluded, the teacher assesses and provides answers to the challenges addressed so that students can understand and solve the problems given.

## Conclusion

This study provides clear evidence that the Problem Submission and Solving (JUCAMA) learning model significantly improves students' mathematical communication skills compared to traditional direct instruction. Statistical analysis confirmed a significant difference between the experimental and control groups, indicating that JUCAMA enables students to articulate mathematical ideas more effectively through symbols, mathematical language, and logical reasoning. The main contribution of this research lies in demonstrating the effectiveness of JUCAMA within the Madrasah Tsanawiyah (MTs) context, where innovative learning models are rarely implemented, and in emphasizing mathematical communication skills, a dimension that has often been overlooked in prior studies that primarily focused on creative or critical thinking.

Practically, these findings suggest that mathematics teachers in MTs and similar educational settings can adopt JUCAMA as an effective instructional strategy to foster active student participation and strengthen students' ability to explain and justify mathematical reasoning. This approach not only supports deeper conceptual understanding but also prepares students for higher levels of mathematical learning. Future research should examine the application of the JUCAMA model in relation to other mathematical skills, such as problem-solving, critical thinking, and reasoning, across different educational contexts, including senior high schools and vocational schools. In addition, integrating technology-based learning tools with JUCAMA is recommended to enhance interactivity, increase student engagement, and provide richer opportunities for collaborative mathematical communication.

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## Declarations

| | | |
|---|---|---|
| Author Contribution | : | LAD: Conceptualization, Writing – Review Editing, Investigation, and Visualization.<br>CLZ: Methodology, Formal Analysis.<br>RH: Validation, Investigation, and Data Curation<br>DR: Supervision, Project Administration, and Supervision. |
| Funding Statement | : | No funding. |
| Conflict of Interest | : | The authors declare no conflict of interest. |
| Additional Information | : | No additional information is available for this paper. |

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