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# Mathematical Communication Ability in SAVI Learning Model with Mathematics Board Game in terms of Mathematical Resilience

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Abstract

This study aims to examine the quality of SAVI learning model implementation with a board game on mathematical communication skills, analyze the effect of mathematical resilience on mathematical communication skills, and describe mathematical communication skills in terms of mathematical resilience. This study used a mixed method of sequential explanatory type. The population of this research was all seventh-grade students of SMPIT Nidaul Hikmah Salatiga. The results showed that the implementation of the SAVI learning model with a quality math board game improved mathematical communication skills. Students' mathematical resilience has a positive effect on their mathematical communication skills. Students with high mathematical resilience fulfill all indicators of mathematical communication. Medium resilience students met indicators 2 and 3, needed guidance for indicators 1 and 4, and had not yet met indicator 5. Low-resilience students are only able to achieve indicators 1 and 4 with guidance. A special case, a student with high resilience and a habitual background of studying for Olympiads, showed significant differences between verbal and written mathematical communication.



## 1. Introduction

The development of the times is in line with the development of knowledge-based problems (Rahayu & Alyani, 2020). Based on the challenges of the 21st century, education systems around the world are looking for the best solutions to prepare young people who are able to face life and work with increasingly complex requirements (Cretu, 2017). Six skills or proficiencies are the criteria that every individual must have to face the challenges of the 21st century, namely: critical thinking, collaboration, communication, creativity, citizenship/culture, and character education/ connectivity (Anugerahwati, 2019; Rafianti et al., 2018; Rahayu & Alyani, 2020).

Mathematical communication skills are one of the important abilities that must be developed by students. Because with mathematical communication students are able to organize their mathematical thinking, both orally and in writing so that it can help in building ideas (Ramadhan & Minarti, 2018). In addition, mathematical communication skills are the essence of teaching, learning, and accessing mathematics (Peressini and Bassett in Hendriana et al., 2017). Baroody suggested that there are at least two reasons why mathematical communication needs to be developed by students in mathematics education. The two reasons are: (1) mathematics is not just a tool for thinking, a tool for finding patterns, solving problems or drawing conclusions, but mathematics also acts as a social activity in learning; (2) mathematics as a means of interaction between students and also between teachers and students (Deswita & Kusumah, 2018).

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The reality that occurs in Indonesia, that the mathematical communication skills of Indonesian students are still low and unsatisfactory. This can be seen from the results of the international study of the Programme for International Student Assessment (PISA) in 2022 organized by the OECD (Organization for International Student Assessment) which shows that the mathematics achievement of Indonesian students is ranked 9th from the bottom (70) with an average score of 366 (Tohir, 2019). The aspects assessed in PISA include comprehension, problem solving, reasoning, and communication skills (Gardenia in Abdi & Hasanuddin, 2018). The PISA results above indicate that the mathematical communication of Indonesian students is still quite low, which affects the low scores of the results of international studies conducted. Less than optimal mathematical communication skills of students are also still found at the junior high school level, one of which is SMPIT Nidaul Hikmah Salatiga.

After conducting a preliminary study to measure students' initial mathematical communication skills, it was found that the average scores of students' mathematical communication skills in two classes were 63.92 and 62.50. The average of the two classes has not met the expected minimum completeness criteria of 70. Based on these results it is also obtained that only 20 students out of 60 students or 33% are complete.

The results of observations on mathematics learning in one of the classes at SMPIT Nidaul Hikmah, obtained information that indeed students' mathematical communication is still low. It can be seen from students' difficulties in solving mathematical communication problems, students also have difficulty discussing with peers. It can be seen in the classroom that the process of solving problems is fully guided by the teacher, so that students do not have the opportunity to think and solve mathematical problems. In addition, students also seem to have no fighting power in solving mathematical problems, students easily give up. This shows that students' mathematical resilience is still low. The reality in the field has shown that students' mathematical communication skills are still not optimal. In addition, the learning applied has not been qualified towards mathematical communication. Therefore, it is necessary to make an effort to develop students' mathematical communication skills. One of these efforts is to apply a learning model that is not only teacher-centered, but also student-centered (Fauziah et al., 2017). Unfortunately, in the field there are not many learning models that can improve students' mathematical communication.

One of the effective learning models to increase and improve mathematical communication skills is the SAVI learning model (Fauziah et al., 2017; Kusumaningsih et al., 2019). SAVI (Somatic, Auditory, Visualization, Intellectually) learning model is a learning model that utilizes and uses all the senses that students have (Fauziah et al., 2017). SAVI is a learning model that combines physical movement and intellectual activity and all the senses that have a major effect on learning (Kusumaningsih et al., 2019). The SAVI learning model aims to increase student activity in the learning process so that it can improve mathematical communication skills (Siregar, 2018).

The components of the SAVI learning model include: a) Somatic (learning by doing and moving), namely body movements or body activities so that students experience and do; b) Auditory (learning by speaking and hearing), namely by listening, listening, speaking, presenting, arguing, expressing opinions, and responding; c) Visualization (learning by observing and describing), namely learning must use the senses of the eyes through observing, drawing, demonstrating, reading, using media and props; d) Intellectually (learning by solving problems and thinking), namely learning must use thinking skills (Siregar, 2018).

In addition to using the right learning model, educational learning media can also help improve mathematical communication skills. One of the learning media that can be used is board games. Board games or commonly called board games are games that can teach players to predict temporary results to move and recognize patterns in the media as models or props in learning (Nusantara & Irawan, 2012). Board game learning media is not only used to play and compete, but also trains students' activeness in communicating with playing opponents (Widiyanto & Yunianta, 2021). The board game media fulfills the principles of the SAVI learning model. So, the SAVI learning model can be combined by using board game learning media.

There are many affective aspects that correlate with cognitive abilities. Mathematical resilience is one of the many affective abilities that students have. Mathematical resilience affects learning outcomes, problem solving, mathematical communication, mathematical connections, creative thinking, and logical reasoning skills (Azizah & Abadi, 2022). Mathematical resilience is a positive attitude in overcoming anxiety, fear of challenges and difficulties in learning mathematics to obtain solutions (Asih et al., 2019).

Mathematical resilience includes an attitude of perseverance in facing difficulties, working or learning collaboratively with peers (Dweck in Hendriana et al., 2017).

This study was conducted with the aim to: (1) test the quality of the implementation of SAVI learning model with board game on mathematical communication skills of seventh grade students; (2) analyze the effect of mathematical resilience on mathematical communication skills of seventh grade students on the implementation of SAVI learning model with mathematics board game; (3) describe the mathematical communication skills of seventh grade students on the implementation of SAVI learning model with board game in terms of mathematical resilience.

## 2. Methods

The design model used in this research was The Nonequivalent Posttest-Only Control Group Design. In this design there were two groups, the first group was the experimental group and the second group was the control group. The experimental group was given treatment in the form of applying the SAVI learning model with board games, while the control group was given treatment as usual, namely learning with the Problem Based Learning model. After getting different treatments, the two groups were given a posttest. The postest given to the experimental group was the same as the postest given to the control group.

This research procedure was explained through the following steps: (1) selection of research sites; (2) obtaining research permits; (3) initial observations and preliminary studies; (4) preparation of research designs; (5) preparing research instruments; (6) conducting feasibility trials of instruments in trial classes; (7) implementing SAVI learning with mathematical board games in experimental classes and implementing Problem Based Learning in control classes; (8) filling out the learning implementation sheet (9) giving student response questionnaires; (10) giving student mathematical communication ability test questions; (11) giving student mathematical resilience questionnaires; (12) conducting interviews with students; (13) compiling research results.

The population in this study were all seventh grade students of SMP IT Nidaul Hikmah Salatiga in the 2023/2024 academic year. Based on simple random sampling technique, class VIIA was selected as the experimental class, class VIIB as the control class. The selection of subjects in this study used puposive sampling technique. The purposive sampling technique is a data source sampling technique with certain considerations (Sugiyono, 2016). The research subjects selected in this study were all students in the experimental class. This research subject was chosen to obtain a description of students' mathematical communication skills based on students' mathematical resilience.

Data collection techniques in this study were tests (mathematical communication skills), questionnaires, interviews, observations, and documentation. The instruments of this study consisted of mathematical communication ability test questions, mathematical resilience questionnaire, student response questionnaire, interview guidelines, observation sheet of learning implementation. The learning tools used include teaching modules and student worksheets. The research instruments and learning tools were validated by 2 Unnes mathematics lecturers, 1 mathematics teacher, and 1 psychology expert.

The students' mathematical resilience questionnaire was used to map the students' mathematical resilience level. Students' mathematical resilience level was then categorized into three types, namely high mathematical resilience level, medium mathematical resilience level, and low mathematical resilience level.

The learning quality indicators used in this study use learning quality indicators according to Danielson (2013). Learning quality assessment includes planning, implementation, and assessment stages. Activities carried out at the planning stage are analyzing the validation of learning devices by expert validators and testing research instruments. Furthermore, the activities carried out at the implementation stage are to observe the learning process which includes observation of teacher skills using the learning implementation observation sheet, and student responses to the learning process. These aspects should be categorized as at least good. While the activities carried out at the assessment stage are to analyze the data that has been obtained. The assessment stage in this study contains a reflection of learning in the form of an assessment of the results of mathematical communication skills on the implementation of the SAVI learning model with a math board game.

## 3. Results & Discussions

### *3.1 Quality of Implementation of SAVI Learning Model with Math Board Game on Mathematical Communication Ability*

In the planning stage, the learning tools that have been designed are validated for their feasibility by expert validators. The results of the validation of research instruments and learning devices are described in Table 1 below.

**Table 1.** Results of Instrument and Learning Device Validation

| Instrument | Percentages | Description |
|---|---|---|
| Teaching Module | 92% | Very Good |
| Worksheets | 84% | Good Enough |
| Test Questions | 89% | Very Good |
| Resilience Questionnaire | 84% | Good Enough |
| Response Questionnaire | 93% | Very Good |
| Interview Guidelines | 90% | Very Good |
| Observation Sheet | 88% | Very Good |

The instrument trial was conducted in the test class. The results of the analysis of the mathematical communication ability test questions showed that the 4 items tested could be used in the study. In addition, it is known that 40 question items on the mathematical resilience questionnaire tested can be used in research.

In the implementation stage, observations were made of the implementation of SAVI learning with math board games and the administration of student response questionnaires to learning. The average total score of the observation of the implementation of learning from the 1st to the 6th meeting was 4.47 with a very good category. Then, the average percentage of the total score of student responses is 87% with very positive criteria. This result shows that the teacher's ability to manage learning from the first to the sixth meeting is categorized as very good.

After conducting the learning stage and working on mathematical communication ability test questions, the results of student mathematical communication ability test data were obtained. The results of this study were then analyzed at the assessment stage. Before the data is analyzed, the data prerequisite test is applied first.

The results of the normality test of the final data of mathematical communication skills of experimental and control class students using the help of IBM SPSS Statistic 25 software, with the Shapiro-Wilk test obtained a significance value for the experimental class is $sig = 0.693 > 0.05$ while the control class is $sig = 0.288 > 0.05$. Based on the test criteria, $H_0$ is accepted. So, it can be concluded that the final data of mathematical communication ability of experimental and control classes come from normally distributed populations.

The results of the homogeneity test of the final data of mathematical communication skills of experimental and control class students using the help of IBM SPSS Statistic 25 software, with the Levene Statistic test is $sig = 0.211 > 0.05$. Based on the test criteria, $H_0$ is accepted. So, it can be concluded that the final data of mathematical communication ability of the experimental class and control class have the same variance or homogeneous.

The results of the average test of the final data of mathematical communication skills of experimental class students were carried out with the One Sample t-test test using the help of IBM SPSS Statistic 25 software. For a significant level $(\alpha)$ of 5% and degrees of freedom 29, the value of $t_{(0.95)(29)}$ is $1.70$. Since $6.189 > 1.70$, then $H_0$ is rejected and $H_1$ is accepted. So, the average mathematical communication ability of students with SAVI learning model with board game is more than or equal to the actual completion limit of 67 determined, meaning that it has reached individual learning completeness.

Proportion testing using the z test was used to determine the completeness of the experimental class. Based on the calculations carried out, the $z_{\text{count}}$ value is 1.897. For a significant level $(\alpha)$ of 5%, the value of $z_{(0.45)}$ is $1.64$. Since $1.897 > 1.64$, then $H_0$ is rejected and $H_1$ is accepted. So, the percentage of students who are complete in mathematical communication skills with the SAVI learning model with board games is more than or equal to 75% of the total number of students in the class, meaning that it has reached classical completeness.

Furthermore, the independent sample test was applied using the help of IBM SPSS Statistic 25 software. The results of the independent sample test obtained the $t_{count}$value is $3.112$. For a significant level $(\alpha)$ of 5%, the value of $t_{(0.95)(58)}$ is 1.672. Because $3.112 > 1.672$, then $H_0$ is rejected and $H_1$ is accepted. So, the average mathematical communication ability of students in the experimental class is more than the average mathematical communication ability of students in the control class. It can be concluded that the average mathematical communication ability of students with SAVI learning with board games is better than students who get PBL learning.

Then the proportion difference test analysis was carried out. Based on the calculations carried out, the $z_{\text{count}}$value is $2.683$. For a significant level $(\alpha)$ of 5%, the value of $z_{(0.45)}$ is $1.64$. Since $2.683 > 1.64$, then $H_0$ is rejected and $H_1$ is accepted. So, the proportion of students' mathematical communication skills completeness in SAVI learning model with board game is more than the proportion of students' mathematical communication skills completeness in PBL learning.

The results of research and analysis at the preparation, implementation, and assessment stages above show that the quality of students' mathematical communication skills in the SAVI learning model with board games is better than students' mathematical communication skills with PBL learning model. Through the SAVI learning model with board games, students are able to maximize the function of their sensory organs to improve mathematical communication skills. Students are able to develop mathematical communication skills during learning.

The results of this study are supported by Azizah & Purwaningrum (2022) who stated that the SAVI learning model supports students to interact, ask, apply, discuss certain problems that can train students' mathematical communication skills. Then, the math board game media supports the implementation of the SAVI learning model by being more interactive and fun for students. The results of the study are in line with Fadliansyah's research (2019) with the conclusion that learning using board game media is effective in improving mathematical communication skills.

### *3.2 The Effect of Mathematical Resilience on Mathematical Communication Ability in the Implementation of SAVI Learning Model with Math Board Game*

The next analysis is to determine whether there is an influence between mathematical resilience on mathematical communication skills of seventh grade students on the implementation of the SAVI learning model with a math board game. The test conducted is the Linear Regression test using the help of IBM SPSS Statistic 25 software. The results of the Linear Regression test obtained a significance value of $sig = 0.000 < 0.05$. Based on the test criteria, $H_0$ is rejected. This shows that there is a significant influence between mathematical resilience on mathematical communication skills of seventh grade students on the implementation of the SAVI learning model with a math board game. The regression test coefficients table is presented in table 2 below.

**Table 2.** Coefficients Table Output

| | ***Unstandardized Coefficients*** |
|---|---|
| | **B** |
| (*Constant*) | 23.536 |
| Resilience Questionnaire Score | 0.490 |

Based on the Coefficients table, the regression model is obtained as follows.

$$\hat{Y} = 23.536 + 0.49X \qquad (1)$$

The magnitude of the influence of mathematical resilience on mathematical communication skills can be seen from the coefficient of determination. The value of $R\ Square = 0.668$ was obtained. So it is obtained that mathematical resilience has an influence of 66.8% on students' mathematical communication skills, the rest is influenced by other variables. The research results are in line with Suparni et al. (2021) with the results of research data analysis showing that there is a significant influence between mathematical resilience on mathematical communication skills.

### *3.3 Description of Mathematical Communication Ability on the Implementation of SAVI Learning Model with Board Game in terms of Mathematical Resilience*

The grouping of students' mathematical resilience was carried out based on the results of the students' mathematical resilience questionnaire. Furthermore, students' mathematical resilience was grouped into three categories, namely, high mathematical resilience level, medium mathematical resilience level, and low mathematical resilience level. The results of students' mathematical resilience mapping are shown in Figure 1 below.

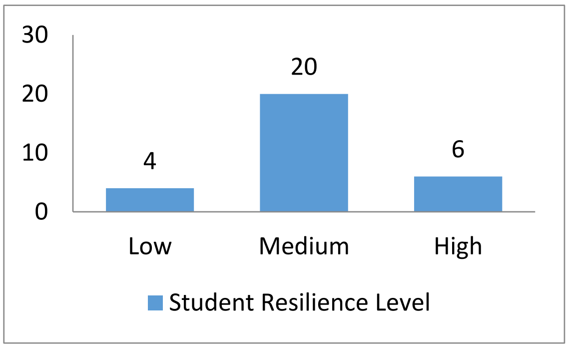


**Figure 1.** Grouping Diagram of Students' Mathematical Resilience Levels

The research subjects were all students in the experimental class or class that received SAVI learning model with math board game. Analysis of mathematical communication ability was conducted based on indicators of mathematical communication ability. Indicators of mathematical communication skills consist of, (1) the ability to connect real objects into mathematical ideas; (2) the ability to use mathematical terms, notations and structures; (3) the ability to explain mathematical ideas, situations and relationships with real objects, images, and algebra; (4) the ability to express and evaluate everyday events in mathematical language or symbols; (5) the ability to communicate answers to problems in the form of conclusions.

After conducting a comprehensive analysis of mathematical communication ability test data, interview data, and data triangulation, the results of the analysis of students' mathematical communication ability were obtained. The analysis of mathematical communication ability was reviewed from three categories of mathematical resilience in the form of high, medium, and low. This was done to identify patterns and characteristics of mathematical communication skills at each level of mathematical resilience.

#### 3.3.1 Mathematical Communication Skills in Terms of High Mathematical Resilience Levels

Students with a high level of resilience have complete characteristics in providing answers to problems, besides that the answers tend to be all correct. Students with a high level of resilience are able to identify problems well, so they are able to connect real objects, images, and diagrams into mathematical ideas. Students with high resilience write completely the known information and the information asked.

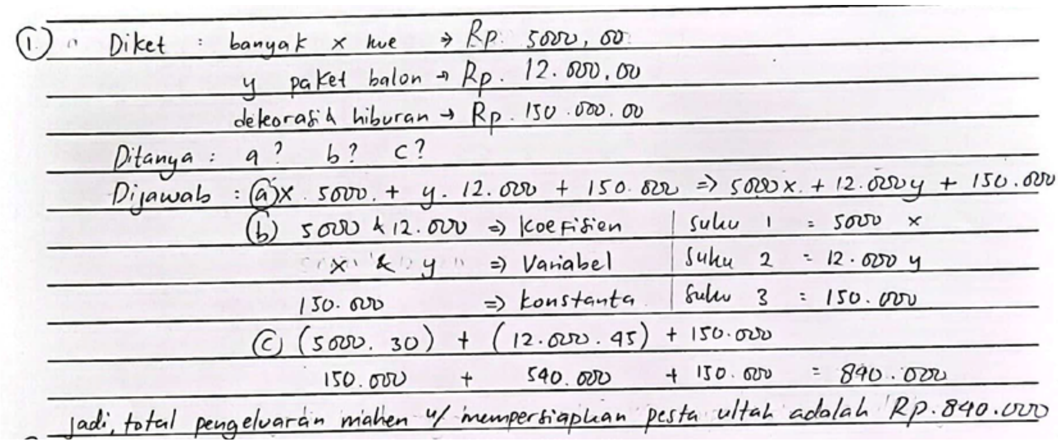


**Figure 2.** Student’s Work Results with High Resilience Levels

Students with high resilience are able to use mathematical terms, notations, and structures well. Every notation used is understood correctly by students. The steps and structure of problem solving are carried out appropriately and coherently, so that the mathematical ideas written down are conveyed well. Students with high resilience are able to explain mathematical ideas, situations, and relationships with real objects and algebra. In addition, students with high resilience are able to state and evaluate everyday events in mathematical language or symbols.

Students with high resilience state the problems given in mathematical ideas, then solve them with logical mathematical solution steps, so as to be able to obtain the required problem evaluation results. Then, students with high resilience tend to communicate answers to problems in the form of appropriate conclusions. The conclusion given is in accordance with the context of the problem in the problem, so that the conclusion of the answer really represents the answer to the problem not only in mathematical form. The results of students' work with a high level of resilience are shown in Figure 2.

### 3.3.2 Mathematical Communication Skills in Terms of Medium Mathematical Resilience Levels

Students with moderate resilience tend to be less complete in solving problems. Students are able to solve problems in mathematical ideas but sometimes incomplete and still need guidance. Students with moderate mathematical resilience are quite capable of connecting real objects to mathematical ideas but still need guidance. Students with moderate mathematical resilience write only known information or write only the information asked, or write it incompletely. Students still need guidance in identifying problems completely. This can also be seen in the learning process, during the process of using the math board game media, students with moderate resilience sometimes need help from their group mates in solving problems. However, students have the desire to solve the problem completely.

Students with moderate resilience are able to use mathematical terms, notations and structures well. In addition, students with moderate resilience have also been able to explain mathematical ideas, situations, and relationships with real and algebraic objects. Students with moderate resilience are able to use effective mathematical symbols to solve the problems given. Moderate resilience students are also able to convert story problems into algebraic form appropriately. The solution used is also correct and in accordance with the problem.

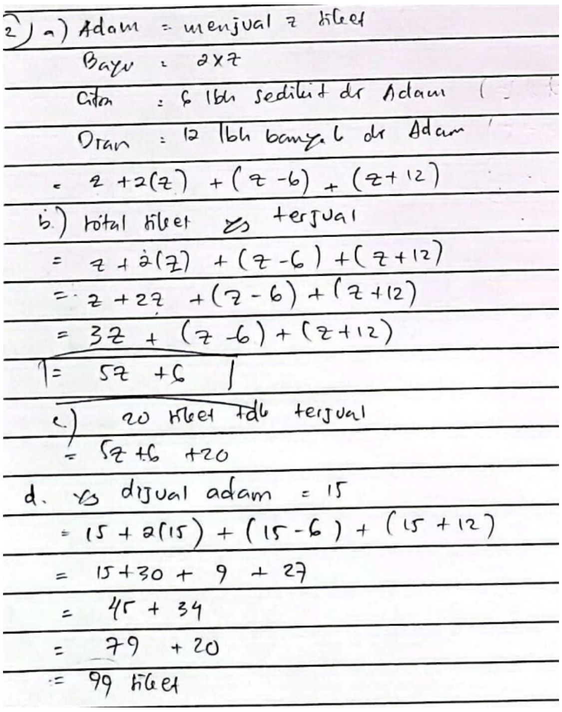

**Figure 3.** Student’s Work Results with Medium Resilience Levels

Students are able to express everyday events in algebraic form. However, students with moderate resilience still need guidance in evaluating problems in mathematical language or symbols. There are still some errors in the calculation process and the thought process in solving the problem. The solution strategy used is correct but the solution given is still not correct because of errors in calculations.

In addition, students with moderate resilience have not been able to communicate the answers to problems in the form of good conclusions. Students with moderate resilience tend to give the final result in mathematical form, so the conclusion given cannot answer the problem completely. Students with moderate resilience consider the conclusion sufficient at that stage. The results of students' work with a medium level of resilience are shown in Figure 3.

Based on the student work results in Figure 3 above, it can be seen that students with a moderate level of resilience cannot express and evaluate everyday events using mathematical language or symbols. Students with moderate resilience still make several errors in describing and evaluating everyday problems in the questions. Students with moderate resilience are less thorough in performing substitutions and algebraic operations, resulting in inaccurate calculations. Based on this, it can be concluded that students with a moderate level of resilience cannot express and evaluate everyday events using mathematical language or symbols.

Figure 3 above also shows that students with moderate resilience cannot write the final answer to the solution in the form of a conclusion that refers to the context of the problem. Students only write mathematical numbers as the final answer. This indicates that students cannot communicate the answer to the problem in the form of a conclusion. Based on this, it can be concluded that students with a moderate level of resilience are unable to communicate the answer to the problem in the form of a conclusion that is appropriate to the context of question.

### 3.3.3 Mathematical Communication Skills in Terms of Low Mathematical Resilience Levels

Students with low resilience have difficulty in identifying completely or even fully understanding the problems given. Students with low resilience are able to connect real objects into mathematical ideas slightly in accordance with the criteria. The known and asked information from the problem has not been written completely. In the interview process, low resilience students were able to identify the known and questionable information from the problem with help from the teacher.

Low resilience students use mathematical language or mathematical symbols that are less accurate in solving problems. Students with low resilience also have difficulty in explaining real situations into algebraic form. Students with low resilience write inappropriate solutions without explanation. Students with low resilience tend to solve problems directly in mathematical form without explanation. Sometimes the solution given is incomplete, or some of the strategies shown are appropriate but incomplete. In the interview process, students with low resilience were able to explain the calculation process given but with guidance from the teacher. In addition, students with low resilience have not been able to communicate the answers to problems in the form of good and appropriate conclusions. The results of students' work with a low level of resilience are shown in Figure 3 below.

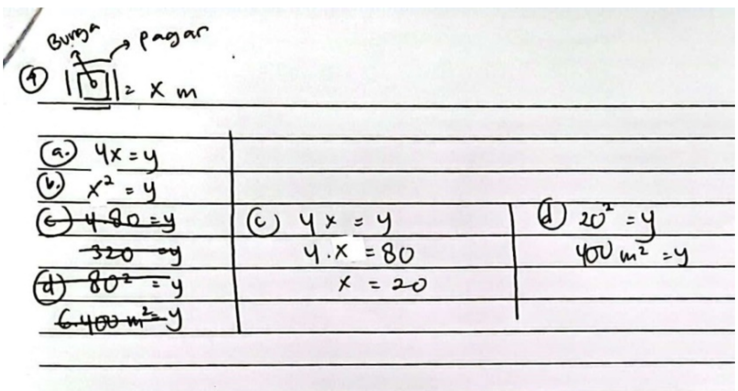


**Figure 4.** Student’s Work Results with Low Resilience Levels

In Figure 4 above, it can be seen that students with low resilience wrote several algebraic expressions, but there was no explanation of the relationships between variables or the meaning of the calculations performed. Although the answers given adequately represented what was asked by the question. For example, in point c), students with low resilience obtained the final answer of "x = 20", this value is correct for the size of the side of the rectangular plot, but there was no apparent effort from the students to explain the mathematical situation clearly. There were several answers that were difficult to interpret, such as whether the variable "y" in point a) is the same as the variable "y" in points b) and d). Therefore, it can be said that students with low resilience are still less able to explain mathematical ideas, situations, and relationships with real objects.

#### 3.3.4 Special Cases of Students' Mathematical Communication Ability

The results showed that there was a special case found. There is one research subject who has high mathematical resilience, but the subject's answer sheet shows that students have communication skills that are not high enough. In addition, there is a uniqueness in the student's problem solving process. During the observation process during learning activities, the subject also showed a high level of resilience. The research subject was quite active in every learning process. The research subject will hereafter be referred to as subject S-12.

Subject S-12 showed a significant gap between oral and written mathematical communication skills. In the written mathematical communication aspect, subject S-12 consistently showed a tendency to minimize the explanation, only writing the final formula or calculation result without including a systematic solution process. In contrast, during the interview, the subject showed good oral mathematical communication skills. The subject was able to explain concepts in a structured manner, use mathematical terms appropriately, and could interpret each step of the solution clearly. This indicated that the subject actually had a deep understanding of the concept. However, his reluctance to write down the complete solution process made this ability not reflected in his written mathematical communication.

Factors affecting this gap can be investigated from the subject's background as a participant in the math olympiad. The subject's experience in learning mathematics competitions has formed a habit of prioritizing efficiency and speed in solving problems, which is reflected in the very brief way of writing answers, and tends to write the conclusion first and then the solution briefly.

Overall, the Olympic experience has shaped this student's unique mathematical communication style. Despite having strong conceptual understanding and good oral communication skills in all mathematical communication indicators, the habit of prioritizing efficiency and speed has made his written mathematical communication very minimalistic. This suggests that while Olympic training is very effective in developing mathematical problem-solving and reasoning skills, special attention needs to be paid to developing written mathematical communication skills to match her oral skills.

## 4. Conclusion

Based on the results of the research and discussion, it is found that the implementation of SAVI learning model with mathematics board game has proven its quality on students' mathematical communication skills. Students' mathematical resilience has a positive effect on students' mathematical communication skills. The description of mathematical communication skills in terms of high mathematical resilience tends to have high mathematical communication skills by fulfilling all indicators; students with moderate resilience levels tend to have moderate mathematical communication skills by fulfilling the 2nd and 3rd indicators, enough to fulfill with guidance for the 1st and 4th indicators, and have not fulfilled the 5th indicator; students with low resilience levels tend to have low mathematical communication skills, enough to fulfill with guidance for the 1st and 4th indicators, and have not fulfilled the other indicators. A special case is found in one student with a high level of resilience who has a background habit of studying for the Olympics shows a unique pattern. Overall, the student showed a significant gap between oral and written communication in the first four indicators, but showed good consistency in the fifth indicator.

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