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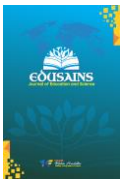

Mathematical Creative Thinking Ability of Eighth-Grade Students in Solving Systems of Linear Equations in Two Variables Based on Mathematical Ability

Ilfi Rahmi Putri Andriyen[1]*

[1]*Universitas Islam Negeri Sjech M. Djamil Djambek Bukittinggi, Bukittinggi, Indonesia*

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Correspondence

E-mail: ilfirhmi11@gmail.com*

A B S T R A C T

Creative thinking is a central goal of school mathematics, yet many junior high school students still rely on memorised procedures. This study aimed to describe the mathematical creative thinking of eighth-grade students with high, medium, and low mathematical ability when solving systems of linear equations in two variables. A descriptive qualitative design was used. Three students were purposively selected from 239 eighth-grade students at MTsN 6 Agam, one at each ability level. Data were collected through a four-item test, in which each item represented fluency, flexibility, originality, or elaboration, and through interviews. The data were analysed through data condensation, data display, and conclusion drawing, and their credibility was checked by technique triangulation. The high-ability student (score 100) fulfilled all four indicators: the student produced four solution pairs, solved a system by both elimination and substitution, used a graphical method, and wrote a complete model and conclusion for a word problem. The medium-ability student (62.5) fulfilled fluency and elaboration but used only one method and did not answer the originality item. The low-ability student (25) partially fulfilled fluency and flexibility and fulfilled neither originality nor elaboration. Originality was the most difficult indicator. Teachers should provide open-ended tasks that require several answers and methods, with support in translating word problems into mathematical models for lower-ability students.

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1. Introduction

One of the goals of school mathematics is to develop students' ability to understand concepts, solve problems, and communicate ideas, as well as to think logically, analytically, systematically, critically, and creatively (Nasional, 2006). Creative thinking has become increasingly important because students are required to deal with complex and non-routine problems. In mathematics, creative thinking is understood as the ability to develop new ideas for solving problems or to offer alternative solutions (Hendriana & others, 2018), and it constitutes an essential component of the mathematics curriculum (Hadar & Tirosh, 2019).

Mathematical creative thinking ability is generally assessed through four indicators, namely *fluency*, *flexibility*, *originality*, and *elaboration* (Munandar, 2009; Wahyuni, 2018). Fluency is the ability to generate many relevant and correct answers; flexibility is the ability to solve a problem using different methods or perspectives; originality is the ability to use unusual or self-generated methods or ideas; and elaboration is the ability to develop and detail ideas until a complete solution is obtained (Lestari & others, 2015). A framework based on the fulfilment of fluency, flexibility, and novelty (Yuli & Siswono, 2010) distinguishes five levels of creative thinking, ranging from level 0 to level 4.

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A number of studies have examined the creative thinking ability of junior high school students. One study (Ardiansyah et al., 2025) analysed the fluency, flexibility, and novelty of seventh-grade students in solving open-ended geometry problems through tests and interviews. Another study (Kholid et al., 2024) classified students' creative thinking in solving non-routine problems and concluded that this ability still needs to be improved. Open-ended problem-solving tests have also been shown to be effective in measuring students' mathematical creativity in terms of both products and processes (Rahayuningsih et al., 2021). However, studies that analyse the fulfilment of all four indicators on the topic of systems of linear equations in two variables (SLETV) by comparing students with high, medium, and low ability in Islamic junior high schools (madrasah tsanawiyah) remain limited.

SLETV is an appropriate topic for examining creative thinking because a single system of equations can be solved using several methods, namely the graphical, substitution, elimination, and combined methods, and many SLETV problems are presented as word problems. Word problems require students to translate everyday situations into mathematical sentences before solving them (Istiqomah & Rahaju, 2014), which makes the ability to elaborate solution steps particularly important.

Observations and interviews with mathematics teachers at MTsN 6 Agam revealed that most eighth-grade students were passive during lessons and had difficulty understanding the intent of word problems. Students tended to memorise solution steps without understanding the underlying concepts, and therefore struggled when facing more complex problems. Teachers also faced constraints owing to the diversity of students' academic abilities and the limited instructional time. These conditions indicate the need for a detailed description of students' creative thinking ability at each ability level as a basis for improving instruction. Accordingly, this study aimed to describe the mathematical creative thinking ability of eighth-grade students at MTsN 6 Agam with high, medium, and low mathematical ability in solving SLETV problems based on the indicators of fluency, flexibility, originality, and elaboration.

2. Methods

2.1. *Research design*

This study employed a qualitative approach with a descriptive design, which aims to describe a phenomenon systematically and in accordance with actual conditions (Sugiyono, 2017). This approach was chosen because the study sought to obtain an in-depth description of how students with different ability levels fulfil each indicator of creative thinking, rather than to test relationships or effects among variables.

2.2. *Research subjects*

The study was conducted at MTsN 6 Agam, West Sumatra, on 26–27 May 2026, in the second semester of the 2025/2026 academic year. The population comprised 239 eighth-grade students. Three subjects were selected purposively, one student each with high, medium, and low mathematical ability. Ability grouping was based on students' mean scores on daily mathematics tests in the preceding topics and on recommendations from the eighth-grade mathematics teachers, using the categories of high ability ($x \geq 80$), medium ability ($65 \leq x < 80$), and low ability ($x < 60$), with the additional consideration that the subjects were able to communicate their thinking well both orally and in writing. To maintain confidentiality, the high-, medium-, and low-ability subjects are referred to as Subject A, Subject B, and Subject C, respectively.

2.3. *Instrument*

The main instrument was the researcher, supported by a mathematical creative thinking test and an interview guide. The test consisted of four essay items on SLETV, developed with reference to the indicators of creative thinking and to a previously developed instrument (Moma, 2015). Item 1 (fluency) asked students to find as many solution pairs as possible for the equation 4,000x + 2,000y = 50,000; Item 2 (flexibility) asked students to solve the system x − y = 8 and x + y = 72 in two different ways; Item 3 (originality) asked students to solve the system 4x + 8y = 96 and 2x + y = 27 with the instruction: "Solve the following system of equations using a method different from the elimination/substitution method you used in the previous item"; and Item 4 (elaboration) was a word problem stating that the price of 2 shirts and 3 T-shirts is IDR 85,000, whereas the price of 3 shirts and 1 T-shirt is IDR 75,000, and students were asked to determine the price of one shirt and one T-shirt in detail. Each item was scored from 0 to 4, so that the total score ranged from 0 to 16, which was then converted into a grade of 0–100. In the scoring rubric for the fluency indicator, a score of 4 was awarded if the student wrote at least two different and correct solution pairs together with their verification, a score of 2 if the student wrote only one correct solution pair, and a score of 0 if the student did not answer or all answers were incorrect. For the flexibility indicator, a score of 4 was awarded if the student solved the system correctly using two different methods presented separately, a score of 2 if the student used only one method or combined the methods into a single solution sequence, and a score of 0 if the answer was incorrect or missing. For the originality indicator, a score of 4 was awarded if the student used a non-routine strategy or representation different from the usual algebraic methods (elimination/substitution) with a correct result, a score of 2 if the student used a different strategy but made computational errors, and a score of 0 if the student did not answer or merely repeated the same routine procedure. For the *elaboration indicator*, a score of 4 was awarded if the student was able to model the contextual problem, solve the system systematically, and draw an appropriate conclusion (or presented complete mathematical steps without a final conclusion), a score of 2 if the student only reached the mathematical modelling stage or did not complete the solution, and a score of 0 if the student did not answer.

2.4. *Instrument validation*

The content validity of the test and the interview guide was examined by two expert validators (lecturers in mathematics education at UIN Sjech M. Djamil Djambek Bukittinggi). The validation results showed that all instrument items were valid, with minor revisions to the wording of the instructions to make them more communicative for eighth-grade students.

2.5. *Data collection*

The test was administered first to the three subjects, after which each subject was interviewed to confirm the answers and to explore the reasons underlying the solution methods used. The interviews were semi-structured, recorded, and transcribed; each interview lasted approximately 10–15 minutes per subject. In the transcripts, P denotes the researcher, whereas A, B, and C denote the subjects.

2.6. *Data analysis and trustworthiness*

The data were analysed in three stages, namely data condensation, data display, and conclusion drawing (Miles et al., 2014). Data trustworthiness was examined through technique triangulation, that is, by comparing data from the same source obtained through different

techniques, in this case tests and interviews (Sugiyono, 2017). The data were considered credible when the test and interview results provided consistent information.

2.7. *Research ethics*

This study obtained permission from the principal of MTsN 6 Agam. The subjects participated voluntarily with the consent of their parents or guardians, and their identities were kept confidential. All identifying information, including the students' full names and classes on the answer sheets, was removed or masked from the documentation images to protect the privacy of the underage participants.

3. Results

The scores of each subject on the four test items are presented in Table 1.

Table 1. Scores of Each Subject on Items 1–4 (Fluency, Flexibility, Originality, Elaboration; Score 0–4 per Item; Total 0–16; Grade 0–100)

Ability	Subject	Fluency	Flexibility	Originality	Elaboration	Total	Grade
High	A	4	4	4	4	16	100
Medium	B	4	2	0	4	10	62.5
Low	C	2	2	0	0	4	25

Table 1 shows that Subject A obtained the maximum score on all four items (16 out of 16; grade 100). Subject B obtained a total score of 10 (grade 62.5), with full scores on the fluency and elaboration items, a score of 2 on the flexibility item, and a score of 0 on the originality item. Subject C obtained a total score of 4 (grade 25), derived solely from the fluency and flexibility items. The sharpest differences among the subjects were found on the originality and elaboration items.

The test results were then confirmed through interviews. The following section describes each subject's answers to the four items together with the supporting interview findings.

3.1. *Subject A (High Mathematical Ability)*

Subject A obtained a score of 4 on every item.

3.1.1. *Item 1 (Fluency)*

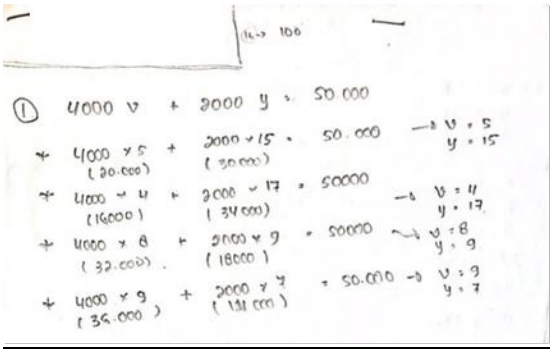

Figure 1. Subject A's Answer to Item 1 (Fluency)

On Item 1, Subject A wrote four different solution pairs for the equation 4,000x + 2,000y = 50,000, namely (5, 15), (4, 17), (8, 9), and (9, 7), and verified each pair by substitution. This answer demonstrates a high level of fluency because the subject generated many relevant and correct answers.

3.1.2. *Item 2 (Flexibility)*

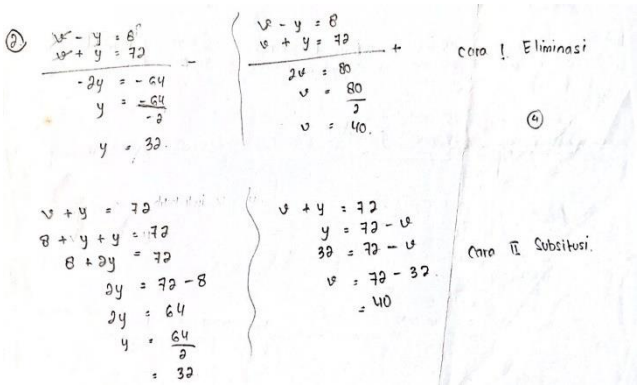

Figure 2. Subject A's Answer to Item 2 (Flexibility)

On Item 2, Subject A solved the system x − y = 8 and x + y = 72 in two different ways, namely elimination and substitution, and labelled each method ("Method I Elimination" and "Method II Substitution"). Both methods yielded x = 40 and y = 32. This demonstrates flexibility, that is, the ability to use different approaches to the same problem.

3.1.3. *Item 3 (Originality)*

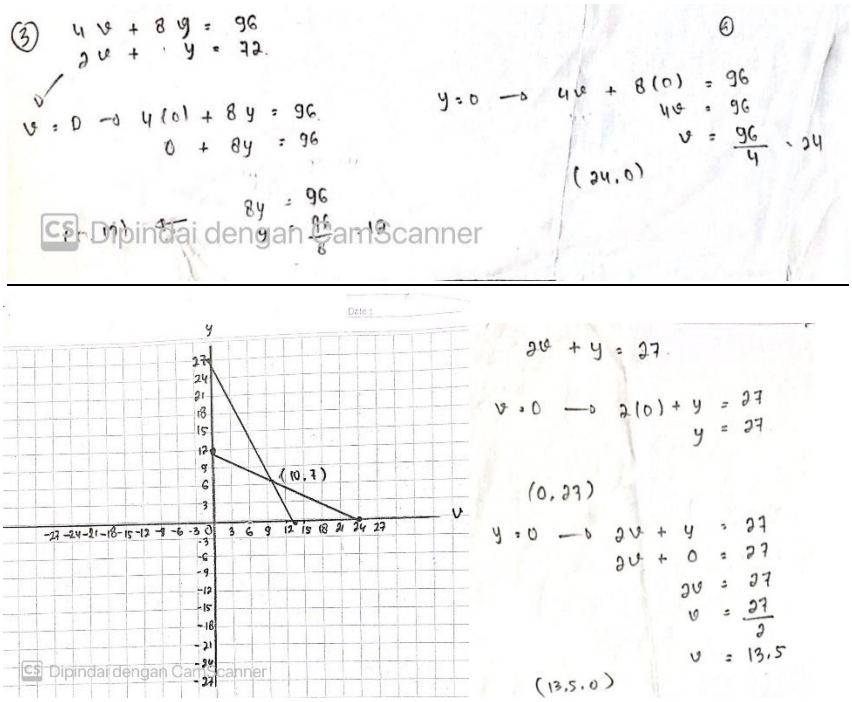

Figure 3. Subject A's Answer to Item 3 (Originality)

On Item 3, Subject A solved the system 4x + 8y = 96 and 2x + y = 27 using the graphical method. The subject determined the intercepts of each line with the coordinate axes, namely (0, 12) and (24, 0) as well as (0, 27) and (13.5, 0), drew both lines, and then obtained the point of intersection (10, 7). The use of the graphical method, which differs from the method used in the previous item, demonstrates originality in selecting a solution strategy.

3.1.4. *Item 4 (Elaboration)*

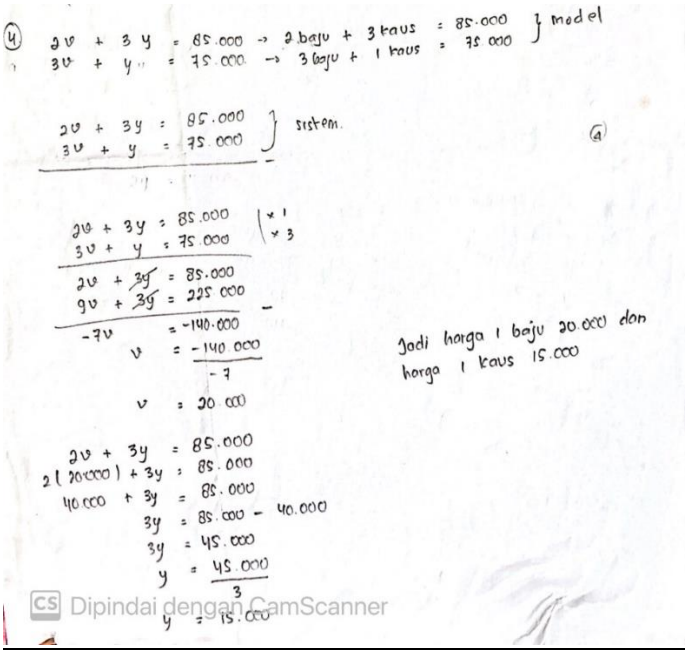

Figure 4. Subject A's Answer to Item 4 (Elaboration)

On Item 4, Subject A constructed the mathematical model 2x + 3y = 85,000 and 3x + y = 75,000, solved it using elimination and substitution, and then wrote the conclusion that the price of one shirt was IDR 20,000 and that of one T-shirt was IDR 15,000. These complete and detailed steps demonstrate elaboration ability.

Interview excerpt with Subject A:

P: "For Item 3, why did you choose to draw a graph instead of directly using elimination as in Item 2?"

A: "Because the item asked me to use a different method from before, so I first found the points where the lines cross the x-axis and the y-axis, and then drew the lines on graph paper until I found the intersection at (10, 7)."

P: "What about Item 4, did you have any difficulty converting the word problem into equations?"

A: "No, I let the shirt be x and the T-shirt be y, and then I solved it with elimination and substitution until I found the unit prices."

3.2. ***Subject B (Medium Mathematical Ability)***

Subject B obtained a total score of 10 (grade 62.5).

3.2.1. *Item 1 (Fluency)*

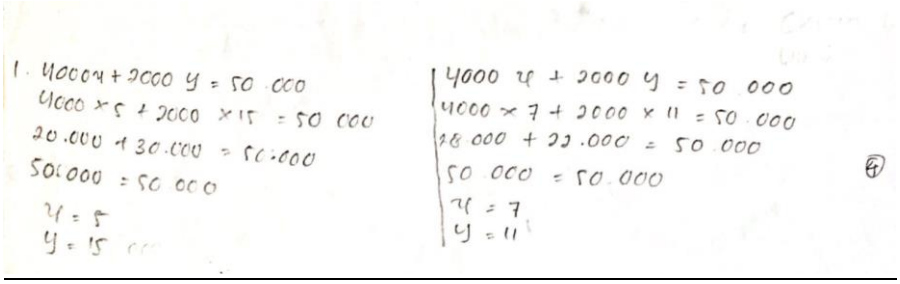

Figure 5. Subject B's Answer to Item 1 (Fluency)

On Item 1, Subject B wrote two correct solution pairs, namely (5, 15) and (7, 11), and verified them by substitution. According to the scoring rubric for the fluency indicator, the ability

to write at least two correct alternative solutions together with their verification meets the criterion for the full score (score 4).

3.2.2. *Item 2 (Flexibility)*

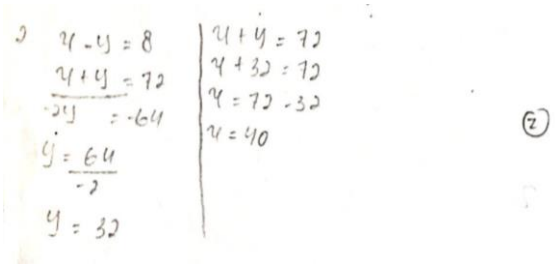

Figure 6. Subject B's Answer to Item 2 (Flexibility)

On Item 2, Subject B obtained y = 32 through elimination and x = 40 through substitution. These two steps constitute a single solution sequence (the combined method) rather than two different methods; therefore, Subject B obtained a score of 2 and did not fully meet the flexibility indicator.

3.2.3. *Item 3 (Originality)*



Figure 7. Subject B's Answer Sheet for Item 3 (Not Answered)

Subject B did not write any answer for Item 3 (score 0); therefore, the originality indicator was not met.

Interview excerpt with Subject B:

P: "Why did you not attempt Item 3 at all?"

B: "I was confused. I usually only memorise the elimination and substitution methods. If I used another method, I was afraid of getting it wrong, and the time was almost up."

3.2.4. *Item 4 (Elaboration)*

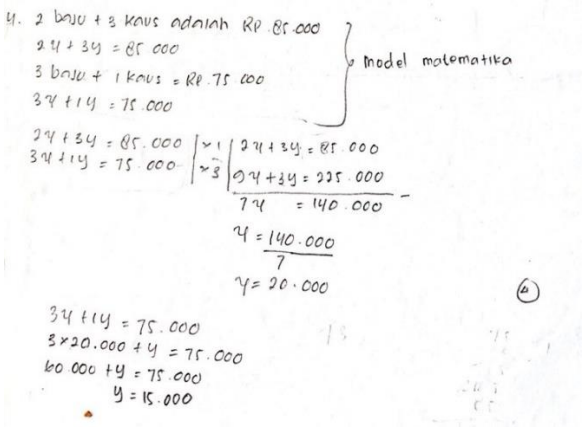

Figure 8. Subject B's Answer to Item 4 (Elaboration)

On Item 4, Subject B constructed an appropriate mathematical model, solved it using elimination and substitution, and obtained x = 20,000 and y = 15,000 (score 4). However, Subject B did not write a conclusion in the context of the problem, namely the price of one shirt and one T-shirt.

3.3. *Subject C (Low Mathematical Ability)*

Subject C obtained a total score of 4 (grade 25).

3.3.1. *Item 1 (Fluency)*

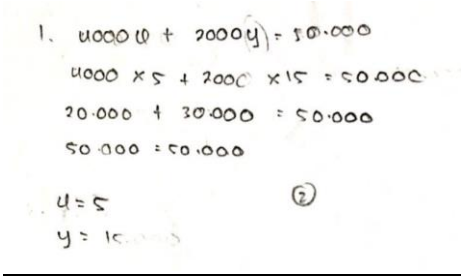

Figure 9. Subject C's Answer to Item 1 (Fluency)

On Item 1, Subject C wrote only one solution pair, namely (5, 15), and verified it by substitution (score 2). Subject C was not yet able to generate several different answers.

3.3.2. *Item 2 (Flexibility)*

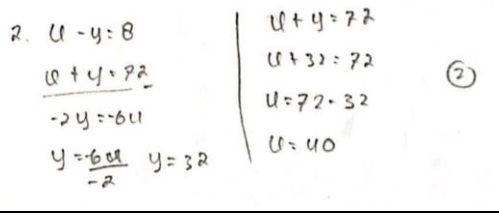

Figure 10. Subject C's Answer to Item 2 (Flexibility)

On Item 2, Subject C used the same steps as Subject B, namely elimination to obtain y = 32 and substitution to obtain x = 40 (score 2). Subject C did not yet use two different methods.

3.3.3. *Item 3 (Originality)*



Figure 11. Subject C's Answer to Item 3 (Originality)

On Item 3, Subject C solved the system 4x + 8y = 96 and 2x + y = 27 using elimination and obtained the correct answer (x = 10, y = 7). However, this answer received a score of 0 because Item 3 specifically measured the originality indicator, which requires the use of a non-routine strategy or a different representation, such as the graphical method, beyond the usual algebraic methods already used in Item 2. Subject C continued to use exactly the same routine elimination and substitution procedure as in the previous item and thus did not demonstrate any novelty of strategy. This indicates that Subject C was able to apply routine procedures but did not yet demonstrate originality.

3.3.4. *Item 4 (Elaboration)*



Figure 12. Subject C's Answer Sheet for Item 4 (Not Answered)

Subject C did not write an answer for Item 4 (score 0); therefore, the elaboration indicator was not met.

Interview excerpt with Subject C:

P: "Your answer to Item 3 was actually correct. Why did you still use the elimination method?"

C: "I don't know any method other than elimination, so I just used the method usually taught in class."

P: "Then what difficulty did you have with word problem number 4 that you did not manage to write an answer?"

C: "I was confused about changing the sentences about the prices of the shirts and T-shirts into the letters x and y. If it is already in the form of numbers and letters, like Items 1 to 3, I can still do it."

4. Discussion

This study aimed to describe the mathematical creative thinking ability of students with high, medium, and low ability in solving SLETV problems. The results reveal a hierarchical pattern: the high-ability subject fulfilled all four indicators, the medium-ability subject fulfilled the fluency and elaboration indicators, whereas the low-ability subject only partially fulfilled the fluency and flexibility indicators. This pattern is consistent with Siswono's (2010) framework, which distinguishes levels of creative thinking based on the fulfilment of fluency, flexibility, and novelty, as well as with the finding that students' creative thinking in solving non-routine problems still needs to be improved (Kholid et al., 2024).

The most notable difference was found in the originality indicator. Only Subject A used a method different from the routine procedure, namely the graphical method in Item 3. Subject C actually obtained the correct answer to this item, but by using the same method as in the previous item, whereas Subject B did not answer it. This indicates that mastery of elimination and substitution procedures has not been accompanied by the ability to select or create alternative strategies. This finding is consistent with the observed classroom conditions, in which students tended to memorise solution steps without understanding the underlying concepts. Similar studies using open-ended tests and interviews have also emphasised the importance of analysing fluency, flexibility, and novelty together with students' solution processes (Ardiansyah et al., 2025; Rahayuningsih et al., 2021).

In Item 4, which was a word problem, Subjects A and B were able to construct and solve the mathematical model, but only Subject A wrote a conclusion in the context of the problem, whereas Subject C did not answer. The difficulty in understanding the intent of word problems, as observed in the classroom, appears to have the greatest impact on low-ability students. This is in line with the view that solving word problems requires the ability to translate situations into mathematical sentences (Istiqomah & Rahaju, 2014).

In practical terms, teachers need to present open-ended SLETV problems that require more than one answer or method, for example by asking students to solve the same system

using the graphical, substitution, and elimination methods and then compare them, and to provide guidance (*scaffolding*) in translating word problems into mathematical models for low-ability students. Open-ended tasks are important because Indonesian students are still unaccustomed to solving open-ended problems (Lestari et al., 2025).

This study has several limitations. The subjects consisted of only three students; therefore, the findings cannot be generalised to all eighth-grade students at MTsN 6 Agam. Each indicator was also measured by only one item, so differences between indicators may have been influenced by item difficulty. Future studies are recommended to involve more subjects, use several items for each indicator, and analyse students' thinking processes in greater depth through task-based interviews.

5. Conclusion

The mathematical creative thinking ability of the three subjects in solving SLETV problems differed according to their level of mathematical ability. The high-ability subject fulfilled all four indicators, namely fluency, flexibility, originality, and elaboration. The medium-ability subject fulfilled the fluency and elaboration indicators but did not yet demonstrate flexibility and originality. The low-ability subject only partially fulfilled the fluency and flexibility indicators and did not yet demonstrate originality and elaboration. Originality was the most difficult indicator to fulfil. Therefore, SLETV instruction should provide opportunities for students to generate a variety of answers and solution methods, accompanied by guidance in understanding word problems for low-ability students.

Declarations

Author Contribution Statement

Ilfi Rahmi Putri Andriyen: designed the study, collected and analysed the data, and wrote the draft manuscript.

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Data Availability Statement

The research data, consisting of anonymised answer sheets and interview transcripts, are available from the corresponding author upon reasonable request.

Declaration of Interests Statement

The author declares no competing financial interests or personal relationships that could have influenced the work reported in this paper.

Declaration of AI Use

The author used an artificial intelligence tool to assist with translation and language editing of the manuscript. All content has been reviewed by the author, who takes full responsibility for the content of the publication.

Additional Information

Correspondence and requests for materials should be addressed to Ilfi Rahmi Putri Andriyen, Mathematics Education Study Program, UIN Sjech M. Djamil Djambek Bukittinggi, e-mail: ilfirhmi11@gmail.com

ORCID

Ilfi Rahmi Putri Andriyen 0009-0008-3050-9699

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