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HOW ARE STUDENTS' CREATIVE REASONING ABILITIES IN SOLVING STRAIGHT-LINE EQUATION PROBLEMS?

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ABSTRACT

Creative reasoning is a person's ability to solve mathematical problems in a manner of thinking that deviates from the norm, yet remains logical and grounded in a strong mathematical foundation. While crucial for students, many have not yet attained proficiency in creative reasoning, necessitating comprehensive research on the subject. This study aims to elucidate students' creative reasoning abilities in tackling straight-line equation problems, focusing on indicators such as creativity, plausibility, and anchoring. Employing a qualitative approach with a case study design, the research involved three students from Madrasah Tsanawiyah who had studied straight-line equations. The primary instrument was the researcher, supported by a creative reasoning ability description test and interviews. Data collection utilized triangulation techniques, encompassing tests and interviews. Analysis of the research findings entailed describing students' creative mathematical reasoning abilities for each creative reasoning indicator in straight-line equation material. Results indicated that while students could provide correct and reasonable arguments in solving mathematical problems, they struggled to devise alternative methods and employ strategies based on mathematical concepts. Consequently, they only met the plausibility criterion, falling short in creativity and anchoring. Thus, it can be concluded that students have not yet achieved creative reasoning proficiency in solving straight-line equation problems.

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INTRODUCTION

Reasoning is an integral aspect of mathematics learning. Mathematical reasoning, often referred to in the context of mathematics, is the process of following a line of inquiry to formulate statements and construct arguments to arrive at and justify conclusions (Barnes, 2021). It is also characterized as engaging in cognitive activities based on available facts or data to derive statements or conclusions, thereby resolving mathematical problems (Dwirahayu et al., 2021). Moreover, mathematical reasoning entails executing procedural solutions to mathematical problems and providing justifications for the solutions (Waluyo et al., 2021). The PISA 2022 framework highlights that mathematical reasoning involves constructing arguments, interpretations, and conclusions based on given statements (OECD, 2023).

According to these definitions, mathematical reasoning involves critical thinking, investigation, and evaluation processes to generate statements, arguments, and conclusions grounded in factual data to solve mathematical problems. Consequently, mathematical reasoning plays a crucial role in mathematics education.

The crucial role of mathematical reasoning in mathematics education is underscored by its persistent recognition as a core objective both internationally and nationally. Since 2000, the National Council of Teachers of Mathematics (NCTM) has emphasized reasoning as one of the essential processes students must master in their mathematical learning endeavors (NCTM, 2000). Similarly, despite various curriculum revisions in Indonesia, reasoning remains a key objective in mathematics education. The Merdeka curriculum's latest curriculum explicitly states that mathematics education aims to enable students to employ reasoning to discern patterns and properties, conduct mathematical manipulations to formulate generalizations, compile evidence, and elucidate mathematical concepts and propositions (BSKAP, 2022).

Across many curricula, fostering students' mathematical reasoning is prioritized, reflecting its foundational importance within the mathematics education research community (Jeannotte & Kieran, 2017). Furthermore, beyond being a learning objective, reasoning is a fundamental tool for studying mathematics, as mathematical knowledge is acquired through reasoning processes (Ridwan, 2017). The mathematics education framework places significant emphasis on nurturing students' mathematical reasoning abilities (Marasabessy, 2021). The significance of mathematical reasoning in mathematics education extends to its profound impact on the broader development of research within mathematics education.

Research concerning mathematical reasoning in mathematics education is burgeoning alongside an increase in empirical studies, fostering greater diversity within the field. Hjelte et al. (2020) undertook a systematic inquiry to inductively uncover various types of reasoning discussed in empirical research within mathematics education. Their research revealed the presence of a type of reasoning termed creative reasoning within the broader domain. This classification stems from Lithner (2006), who delineates two distinct reasoning types: imitative and creative. Creative reasoning entails tackling non-routine mathematical problems through unconventional thinking patterns while maintaining a robust mathematical foundation. In contrast, imitative reasoning involves simplistic mathematical thinking characterized by a tendency to replicate previously employed methods (Lithner, 2015; Dwirahayu et al., 2021).

This definition underscores a notable disparity between creative and imitative reasoning, particularly in the strategies employed to solve problems. Creative reasoning boasts several advantages over its imitative counterpart.

The advantages of creative reasoning over imitative reasoning are manifold. Creative reasoning can foster a more profound comprehension of mathematical procedures and concepts. By engaging in creative reasoning, students contemplate mathematical properties within their tasks (Hansen, 2022). Conversely, imitative reasoning fails to reflect an individual's conceptual grasp of mathematics as it often relies solely on rote memorization, lacking meaningful comprehension (Jonsson, 2014).

Students employing creative reasoning are adept at solving problems instructively, offering well-reasoned arguments supported by mathematical principles for their chosen approaches (Granberg & Olsson, 2015). Moreover, when collaborating in group assignments, students demonstrating creative reasoning serve as knowledge catalysts, substantially enhancing group performance (Hershkowitz et al., 2017).

The superiority of creative reasoning is inherently linked to its defining characteristics. Lithner (2008) posits that creative reasoning must satisfy three criteria: creativity, plausibility, and anchoring. This implies that creative reasoning entails the introduction of novel approaches to problem-solving that are both sensible and rooted in mathematical concepts.

Based on the preceding description, it becomes evident that ideally, students possess creative reasoning abilities in their mathematical learning endeavors. However, this ideal scenario does not align with the realities observed in the field. Research conducted by Herman et al. (2018) revealed that students encounter general challenges when it comes to reasoning, with imitative reasoning predominantly characterizing the quality of students' mathematical reasoning. Furthermore, a study by Rohati et al. (2023) indicates that most students still rely on memorized reasoning and algorithms, lacking familiarity with creative reasoning practices. This is evidenced by their limited propensity to generate novel ideas and engage in reasoned mathematical discourse. Similarly, research conducted by Agusti et al. (2023) highlighted the deficiency in students' reasoning skills, with imitative reasoning prevailing and students struggling to engage in accurate reasoning processes.

This prevailing condition underscores students' failure to achieve proficiency in creative reasoning. Consequently, interventions are imperative to bolster the development of students' creative reasoning abilities.

Solutions to foster creative reasoning can commence with more comprehensive research on students' creative reasoning abilities in mathematics learning, mainly focusing on pivotal mathematical topics. According to Hjelte et al. (2020), theories on creative reasoning are overarching and not confined to specific mathematical subjects. Hence, exploring creative reasoning across various mathematical topics, such as equations of straight lines, is feasible. Equations of straight lines hold significance in mathematics as they serve as a conduit between algebraic and geometric concepts. In this domain, students learn to translate geometric images into algebraic equations and vice versa while acquiring fundamental concepts like slope, midpoint, and distance between two points. A deficiency in mastering equations of straight-line material may consequently impede proficiency in algebra and geometry (Agusti et al., 2023). Hence, there is a pressing need for research concerning students' creative reasoning abilities in solving equations of straight-line problems, thereby laying the groundwork for subsequent research to implement tangible solutions to bolster creative reasoning abilities.

Despite the importance of creative reasoning ability, many students struggle to achieve proficiency in this domain. Therefore, conducting in-depth research on creative reasoning in specific mathematical topics, such as equations of straight lines, becomes imperative. Notably, a review of existing literature on creative reasoning reveals a dearth of studies describing the creative reasoning abilities of students in Madrasah Tsanawiyah (MTs) regarding equations of straight lines. Consequently, this research endeavors to elucidate students' creative reasoning abilities in solving equations of straight-line problems, encompassing indicators of creativity, plausibility, and anchoring.

METHOD

This research employs a qualitative approach with a case study design structured into distinct stages as outlined below:

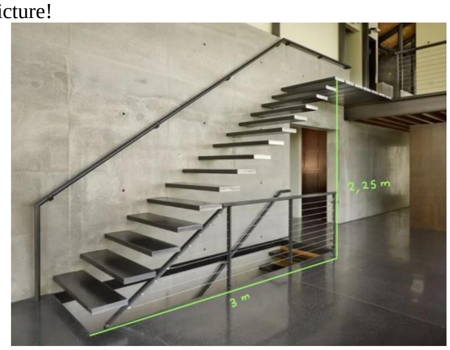
Selection of Research Subjects:

The research subjects comprised three students from the city of Depok who had undergone instruction in equations of straight lines. Recommendations from mathematics educators informed the selection criteria for the subjects. Notably, the chosen students possess unique attributes, namely their enrollment in Madrasah Tsanawiyah and their demonstrated aptitude for mathematics, as assessed by their teachers' observations.

Developing Research Instruments:

The primary instrument for this research is the researcher, complemented by supporting tools, including tests assessing creative reasoning abilities and interview guidelines. The description test comprises three questions representing each indicator of creative reasoning, as Lithner (2008) defined: creativity, plausibility, and anchoring. Creativity pertains to students' capacity to generate diverse problem-solving approaches, plausibility involves their ability to furnish accurate and rational justifications for mathematical solutions, and anchoring entails their adeptness in employing mathematical concepts. The creative mathematical reasoning questions utilized in this study are detailed in Table 1.

Table 1. Instrument for Creative Reasoning Questions

No	Indicator	Question
1.	Creativity	Given the 5 points as follows: $A\ (-4,3),\ B\ (a,1), C\ (1,-2), D\ (b,2), E\ (4,c)$ Determine the values of *a, b,* and *c* so that points A, B, C, D, and E lie on a straight line! (Solve using at least two different methods)
2.	Plausibility	Take a look at the following picture!  For safety reasons, the slope on building stairs should not exceed 0.875. Examine whether the building stairs depicted in the image above meet safety standards. Provide reasoning for your answer!

3.	Anchoring	A line is described by the equation $(a+3)y = 12x$. If the gradient is 3, what is the value of $5a$?

The interview questions were constructed based on the aforementioned creative reasoning indicators. Before implementation, the instrument underwent validation by experts and was deemed suitable for assessing students' creative reasoning abilities.

Data Collection:

Data was gathered through triangulation techniques, utilizing tests and interviews. After studying straight-line equation material, students were administered the creative mathematical reasoning test. Subsequently, interviews were conducted to validate the provided answers.

Data Analysis:

The research findings were analyzed by delineating students' creative mathematical reasoning abilities across each creative reasoning indicator within the context of straight-line equation material.

Data Interpretation

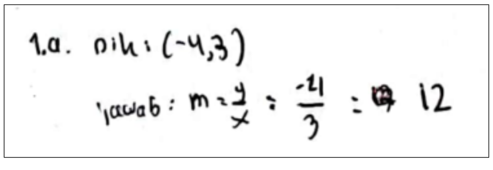
Following data organization and analysis, interpretations were made to reinforce the responses to the research inquiries.

RESULT AND DISCUSSION

Students' creative reasoning abilities are analyzed based on their responses to each question, encompassing indicators of creative reasoning, namely creativity, plausibility, and anchoring. The analysis results are presented according to the responses provided by each subject.

Subject S1

The results of subject S1's work in solving equations of straight-line problems, which include creativity indicators, are illustrated in Figure 1 below:



(a) Original answer from the subject

1. Known: (-4,3)
   Answer: $m = \frac{y}{x} = -\frac{4}{3} = 12$

(b) Translation

Figure 1. S1 subject's responses to creativity indicators

Based on the above picture, it is apparent that subject S1 attempted problem-solving based on their interpretation, but errors occurred in the process. S1 seems to have misunderstood the question, focusing solely on gradients instead of points. Additionally, inaccuracies arose in the calculation of the gradient. The interview with S1 yielded the following insights:

Interviewer: Do you understand how to solve this question?

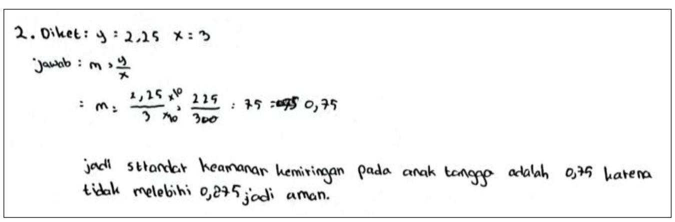
S1: No, I do not grasp the question's meaning.

Interviewer: Why did you calculate the gradient?

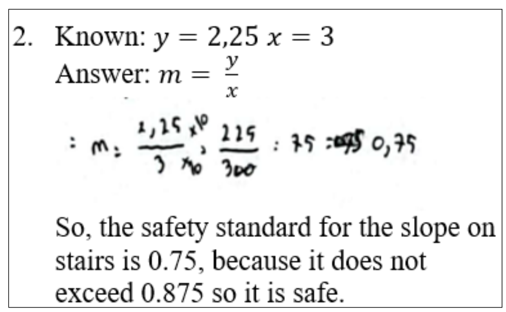
S1: I just calculated based on what I remembered about straight-line concepts. Interviewer: Do you have an alternative approach to solving this problem?

S1: No, I do not.

These responses suggest that S1 has yet to exhibit the creativity indicator in creative reasoning. Furthermore, Figure 2 depicts the results of S1's attempts to solve problems with plausibility indicators.



(a) Original answer from the student



(b) Translation

Figure 2. S1 subject's responses to the plausibility indicator

From the above picture, it's evident that subject S1 can provide correct and reasonable insights and solve problems accurately, with only a minor error occurring in dividing decimal numbers. It should be noted as 100, not 10, although the final answer is correct. The following are the results of the interview with

Interviewer: Do you understand how to solve this question?

S1: I believe I do.

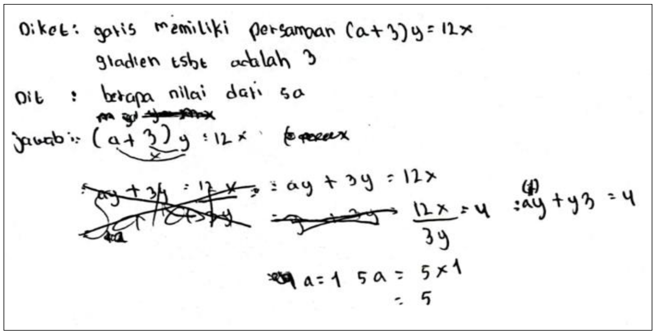
Interviewer: Why did you calculate the gradient?

S1: Because the slope is related to the gradient.

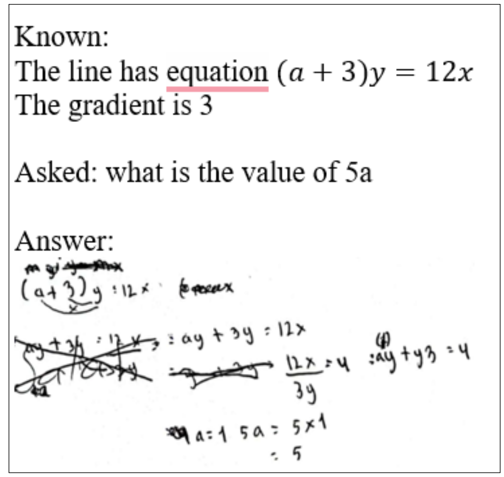
Interviewer: Do you think your answer is plausible?

S1: Yes.

It can be concluded that S1 has achieved the plausibility indicator in creative reasoning. S1 addressed the anchoring indicator represented by question number 3, with the following results in Figure 3.



(a) Original answer from the student



(b) Translation

Figure 3. S1 subject's responses to anchoring indicators

In Figure 3, it is apparent that S1 solved the problem using the correct concept, but errors occurred in the process. While the final results obtained are accurate, there appears to be confusion in addressing the presented questions. The following are the results of the interview with S1 regarding question number 3:

Interviewer: Do you understand how to solve this question?

S1: No, I do not understand.

Interviewer: Why did you choose this method?

S1: I have no idea.

Interviewer: What mathematical concept did you use to solve this problem?

S1: I do not know.

Through the interviews, S1 was unable to elucidate the reasons for the provided answers. This suggests that S1 has yet to achieve the anchoring indicator in creative reasoning.

Subject S2, The results of subject S2's work in solving equations of straight-line problems, which include creativity indicators, are presented in Figure 4 below.

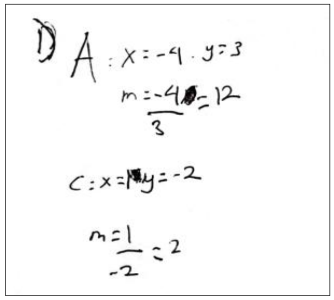


Figure 4. S2 subjects' responses to creativity indicators

Based on the picture above, it is apparent that subject S2 attempted problem-solving based on their interpretation, but errors occurred in the process. S2 only provided gradient values with calculations that were also inaccurate, similar to what S1 did. The following are the results of the interview with S2 regarding question number 1:

Interviewer: Do you understand how to solve this question?

S2: Actually, no.

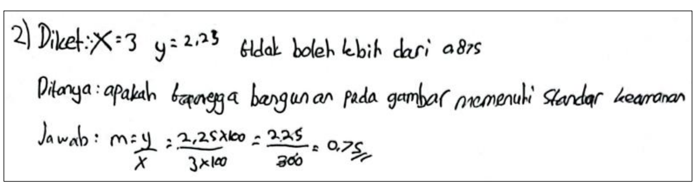
Interviewer: Why did you calculate the gradient?

S2: I thought of using the gradient formula to solve the question.

Interviewer: Do you have another way to solve this problem?

S2: No, I do not.

These results indicate that S2 has yet to achieve the creativity indicator in creative reasoning. Furthermore, Figure 5 presents the results of S2's attempts to solve problems with plausibility indicators.



(a) Original answer of student

2) Known: $x = 3$ $y = 2{,}25$ should not be more than 0.875

Asked: whether the building stairs in the picture meet safety standards

Answer: $m = \frac{y}{x} = \frac{2{,}25 \times 100}{3 \times 100} = \frac{225}{300} = 0{,}75$

(b) Translation

Figure 5. S2 subjects' responses to the plausibility indicator

In Figure 5, it is evident that subject S2 commenced their answer by outlining what they knew and addressing the question prompt. Based on the results of the written work, S2 demonstrated the ability to provide correct and reasonable insights, solving problems accurately. The following are the results of the interview with S2 regarding question number 2:

Interviewer: Do you understand how to solve this question?

S2: Yes.

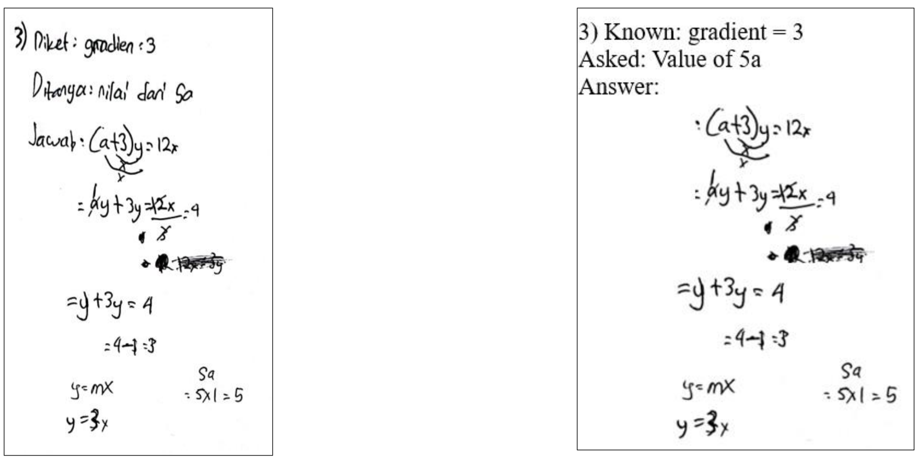
Interviewer: Why did you calculate the gradient?

S2: Because the question pertains to considering safety standards, which are related to slope. In mathematics, slope is synonymous with gradient.

Interviewer: Do you believe your answer is plausible?

S2: Absolutely.

This indicates that subject S2 has fulfilled the plausibility indicators in creative reasoning. S2 addressed the anchoring indicator represented by question number 3, with the following results in Figure 6.



(a) Original Answer of Student (b) Translation

Figure 6. Subject S2's responses to anchoring indicators

In Figure 6, it is evident that subject S2 also commenced their answer by outlining what they knew and addressing the question prompt. Furthermore, it was observed that S2 could solve problems with the correct concept and obtain accurate results, but there were errors in documenting the calculation process. The following are the results of the interview with S2 regarding question number 3:

Interviewer: Do you understand how to solve this question?

S2: Probably.

Interviewer: Why did you choose this method?

S2: Because this method allows me to obtain the value of 5a.

Interviewer: What mathematical concept did you use to solve this problem?

S2: Actually, I used trial and error.

Subject S2 was unable to explain the reasoning behind the answers provided during the interview process. This indicates that S2 has not achieved the anchoring indicator in creative reasoning

Subject S3

The results of subject S3's work in solving equations of straight-line problems, which include creativity indicators, are presented in Figure 7 below

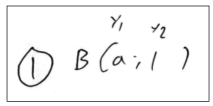


Figure 7. S3 subject’s responses to creativity indicators

Based on Figure 7, it's evident that subject S3 only recorded the coordinates of point B without providing an answer. Here are the interview results of S3:

Interviewer: Do you understand how to solve this question?

S3: No, I don’t understand how to solve this problem.

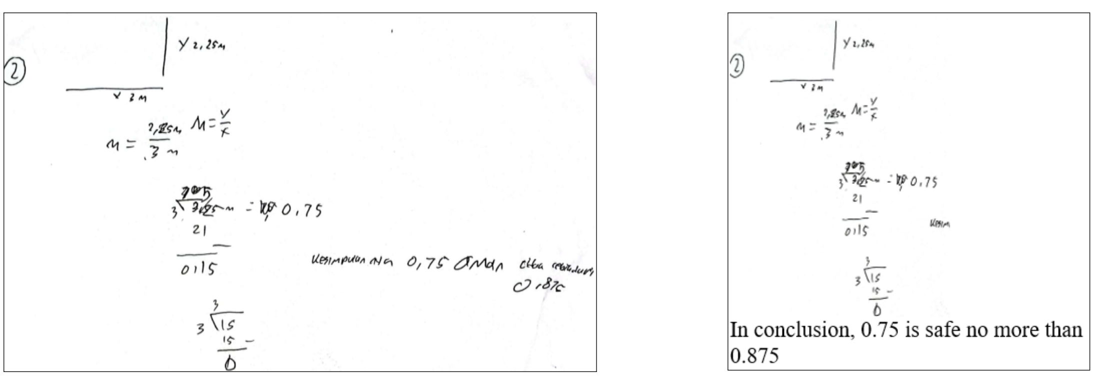
Interviewer: Why did you only write down the coordinates?

S3: I gave up on finding further solutions.

Interviewer: Do you have another way to solve this problem?

S3: No, I don’t.

These results indicate that S3 has not yet achieved the creativity indicator in creative reasoning. Furthermore, the results of S3's attempts to solve problems with plausibility indicators are presented in Figure 8.



(a) Original answer of the student (b) Translation

Figure 8. S3 subject's responses to the plausibility indicator

In Figure 8, it can be observed that subject S3 initiated their response by illustrating the ladder mentioned in the question along with its dimensions. Furthermore, S3 demonstrated the ability to provide correct and reasonable insights, as well as accurate problem-solving. The following are the results of the interview with S3 regarding question number 2:

Interviewer: Do you understand how to solve this question?

S3: Yes, I do.

Interviewer: Why did you calculate the gradient?

S3: Because the gradient is related to the slope in the safety standard mentioned.

Interviewer: Do you believe your answer is plausible?

S3: Yes, it is plausible because I can assert that it's safe based on my calculations.

Thus, it can be inferred that subject S3 has achieved the plausibility indicator in creative reasoning. Subject S3 addressed the anchoring indicator represented by question number 3, with the following results presented in Figure 9.

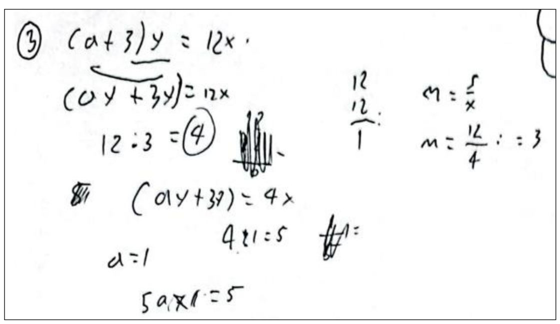


Figure 9. S3 subject's responses to the anchoring indicator

Based on Figure 9, it is apparent that subject S3 managed to obtain the correct results, but there were several confusions in the writing process. The following are the results of the interview with S3 regarding question number 3:

Interviewer: Do you understand how to solve this question?

S3: I don't know.

Interviewer: Why did you choose this method?

S3: I don't know.

Interviewer: What mathematical concept did you use to solve this problem?

S3: Gradient.

Through the interviews, subject S3 was unable to explain the reasons for the answers provided. This indicates that subject S3 has not achieved the anchoring indicator in creative reasoning.

The research results demonstrate similarities in the subjects' creative reasoning abilities. This similarity is evident in the fulfillment of indicators of creative reasoning ability, as presented in Figure 10 below.

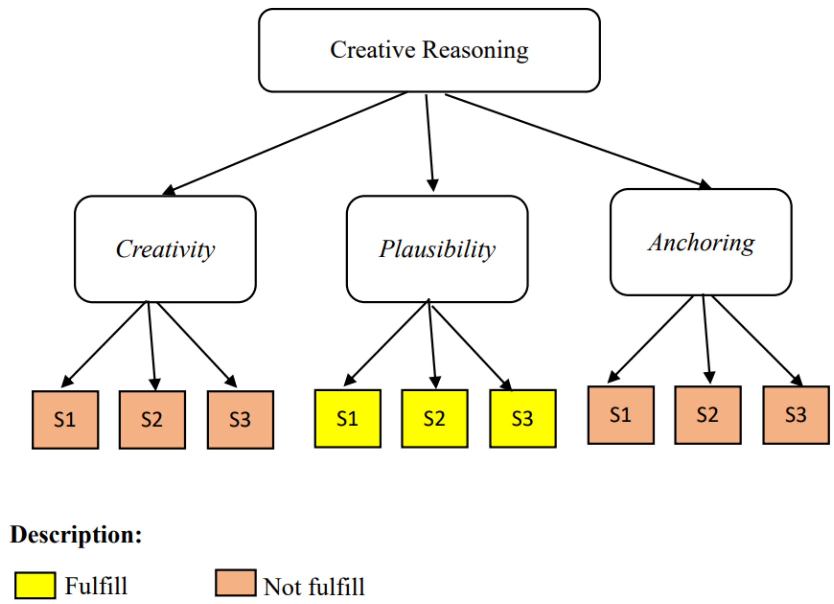


Figure 10. Subject's creative reasoning ability for each indicator

Based on the results obtained, it appears that the research subjects have fulfilled the plausibility indicator by providing correct and reasonable arguments in solving mathematical problems. However, they have not met the creativity indicator, which involves the ability to produce different problem-solving approaches, nor have they fulfilled the anchoring indicator, which pertains to using strategies based on mathematical concepts. Next, these results will be further discussed and analyzed for each indicator.

In question number 1, which assesses creativity indicators, students are expected to generate diverse problem-solving methods for equations of straight-line problems, such as drawing diagrams or utilizing formulas. However, the students' responses indicate a lack of understanding of the basic concept of a straight line. Consequently, they struggled to determine the coordinates of additional points on the line when given the coordinates of two points. Thus, it is evident that students have not achieved the creativity indicator in creative reasoning. This finding aligns with the results of research conducted by Hidayat and Prabawanto (2018), which similarly highlighted students' inadequate mastery of creative mathematical reasoning abilities, particularly in terms of novelty.

As for question number 2, which assesses the plausibility indicator, a picture of a ladder is provided along with its height and length. Students are expected to provide correct and reasonable arguments regarding whether the ladder meets safety standards, considering that the slope on building stairs should not exceed 0.875. The research results indicate that students were able to solve the problem correctly, demonstrating accurate calculations and reasonable arguments. Therefore, it can be concluded that students have fulfilled the plausibility indicator in creative reasoning. This finding is consistent with research conducted by Dwirahayu et al. (2021), where students demonstrated the ability to provide correct and reasonable arguments when solving polyhedron problems.

Furthermore, in questions containing anchoring indicators, such as question number 3, students are expected to utilize strategies based on mathematical concepts. For example, they should apply the concept of one-variable linear equations and algebraic operations to solve the presented straight-line problems. However, students' responses indicate a lack of utilization of strategies based on mathematical concepts, even though they were able to arrive at the correct final answer. This suggests that students have not achieved the anchoring indicators for creative reasoning. These results are consistent with research conducted by Masfingatin et al. (2020), which found that over 50% of students did not meet the mathematical foundation indicator, which aligns with the anchoring indicator. This indicator assesses students' ability to provide arguments based on mathematical properties, such as mathematical definitions and theorems.

In general, it was found that students had not achieved creative reasoning abilities because they did not meet all the indicators of creativity, plausibility, and anchoring. This finding aligns with the research results of Agusti et al. (2023), which revealed that students could not perform creative mathematical reasoning effectively, particularly in equations of straight lines. Furthermore, concerning the research location, namely MTS schools, the results of this research are consistent with the findings of a study by Kusaeri et al. (2022), which indicated that compared to junior high school students, MTS students displayed more varied answers and approaches to completing mathematics tasks. However, in some instances, MTS students demonstrated several unique responses (Kusaeri et al., 2022).

In contrast, a study by Fatimah et al. (2019) showed that students utilized creative reasoning to formulate a sequence of procedures, suggesting predictive statements based on the nature of mathematics. Additionally, research by Dewi et al. (2022) found that although students were not yet capable of reasoning creatively, they could provide logical arguments and offer various problem solutions. Thus, it can be concluded that creative reasoning abilities have not been achieved, indicating the need for efforts to support their attainment.

CONCLUSION

Based on the research and discussion results, students could provide correct and reasonable arguments in solving mathematical problems. However, they struggled to produce different methods and utilize strategies based on mathematical concepts. Consequently, students only met the plausibility indicators and did not fulfill the creativity and anchoring indicators in the creative reasoning assessment. Thus, it can be concluded that students have not achieved creative reasoning in solving equations of straight-line problems.

These findings are expected to serve as a foundation for further research to support the development of creative reasoning in mathematics learning. This study focused specifically on equations of straight-line material. Therefore, future research could explore additional topics to examine the theme of creative reasoning more comprehensively.

REFERENCES

Agusti, F. A., Herman, T., & Zafirah, A. (2023). Kemampuan Penalaran Imitatif dan Kreatif Matematis Siswa SMP Pada Materi Persamaan Garis Lurus. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(1).

Barnes, A. (2021). Enjoyment in learning mathematics: Its role as a potential barrier to children's perseverance in mathematical reasoning. *Educational Studies in Mathematics, 106*(1), 45–63.

BSKAP. (2022). *Capaian Pembelajaran pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah Pada Kurikulum Merdeka*.

Dewi, A. K., Masfingatin, T., & Lusiana, R. (2022, August). Kemampuan penalaran kreatif matematis siswa dalam penyelesaian soal tipe PISA. In *Seminar Nasional Sosial, Sains, Pendidikan, Humaniora (SENASSDRA)* (Vol. 1, No. 1, pp. 891-900).

Dwirahayu, G., Mas'Ud, A., Satriawati, G., Atiqoh, K. S. N., & Dewi, S. (2021). Improving students' mathematical creative reasoning on polyhedron through concept-based inquiry model. *Journal of Physics: Conference Series*, *1836*(1), 012073.

Fatimah, A. T., Pramuditya, S. A., & Wahyudin, W. (2019, February). Imitative and creative reasoning for mathematical problem solving (in context horticultural agribusiness). In *Journal of Physics: Conference Series* (Vol. 1157, No. 4, p. 042092). IOP Publishing.

Granberg, C., & Olsson, J. (2015). ICT-supported problem solving and collaborative creative reasoning: Exploring linear functions using dynamic mathematics software. *The Journal of Mathematical Behavior*, *37*, 48-62.

Hansen, E. K. S. (2022). Students' agency, creative reasoning, and collaboration in mathematical problem-solving. *Mathematics Education Research Journal*, *34*(4), 813–834.

Herman, T. (2018). Analysis of students' mathematical reasoning. *Journal of Physics: Conference Series*, *948*(1), 012036.

Hershkowitz, R., Tabach, M., & Dreyfus, T. (2017). Creative reasoning and shifts of knowledge in the mathematics classroom. *ZDM*, 49, 25-36.

Hidayat, W., & Prabawanto, S. (2018). Improving students' creative mathematical reasoning ability students through adversity quotient and argument driven inquiry learning. *Journal of Physics: Conference Series*, *948*(1), 012005.

Hjelte, A., Schindler, M., & Nilsson, P. (2020). Kinds of mathematical reasoning addressed in empirical research in mathematics education: A systematic review. *Education Sciences*, *10*(10), 289.

Jeannotte, D., & Kieran, C. (2017). A conceptual model of mathematical reasoning for school mathematics. *Educational Studies in mathematics*, *96*, 1-16.

Jonsson, B., Norqvist, M., Liljekvist, Y., & Lithner, J. (2014). Learning mathematics through algorithmic and creative reasoning. *The Journal of Mathematical Behavior*, 36, 20-32.

Kusaeri, K., Arrifadah, Y., & Asmiyah, S. (2022). Enhancing creative reasoning through mathematical task: The quest for an ideal design. *International Journal of Evaluation and Research in Education (IJERE)*, *11*(2), 482–490.

Lithner, J. (2006). *A framework for analysing creative and imitative mathematical reasoning*.

Lithner, J. (2008). A research framework for creative and imitative reasoning. *Educational* Studies in Mathematics, 67, 255–276.

Lithner, J. (2015). Learning mathematics by creative or imitative reasoning. *Selected Regular Lectures from the 12th International Congress on Mathematical Education*, 487–506.

Marasabessy, R. (2021). Study of mathematical reasoning ability for mathematics learning in schools: A literature review. *Indonesian Journal of Teaching in Science*, *1*(2), 79-90.

Masfingatin, T., Murtafiah, W., & Maharani, S. (2020). Exploration of creative mathematical reasoning in solving geometric problems. *Jurnal Pendidikan Matematika*, *14*(2), 155–168.

NCTM. (2000). Standards for School Mathematics. In *Counc. Teach. Math*. Reston VA.

OECD. (2023). *PISA 2022 Assessment and Analytical Framework*. OECD. https://doi.org/10.1787/dfe0bf9c-en

Ridwan, M. (2017). Profil kemampuan penalaran matematis siswa ditinjau dari gaya belajar. *Kalamatika: Jurnal Pendidikan Matematika*, *2*(2), 193–206.

Rohati, R., Kusumah, Y. S., & Kusnandi, K. (2023). Exploring Students' Mathematical Reasoning Behavior in Junior High Schools: A Grounded Theory. *Education Sciences*, *13*(3), 252.

Waluyo, S., Armanto, D., & Mansyur, A. (2021). Analysis of Mathematic Reasoning Ability and Self-Confidence Students Using Models PBL Reviewed from Intelligence Intrapersonal in SMPN 5 Youth Vocationality. *Journal of Education and Practice, 12(16)*.