International Research Journal of Multidisciplinary Scope (IRJMS), 2026;7(3):572-584

Original Article | ISSN (O): 2582-631X DOI: 10.47857/irjms.2026.v07i03.012731

How Directive Decision-making Style Shapes Indonesian Students' Creative Thinking Processes in Mathematics

Fauziah[1,2], Abd Qohar[1*], Santi Irawati[1]

[1]Department of Mathematics, Universitas Negeri Malang, Malang, East Java, [2]Department of Mathematics Education, Universitas Bung Hatta Padang, Padang, West Sumatera, Indonesia. *Corresponding Author's Email: abd.qohar.fmipa@um.ac.id

Abstract

Creative thinking (CT) is increasingly becoming a key focus in mathematics education, particularly in addressing non-routine problems, facilitating the transfer of knowledge to new contexts and fostering innovation. In this regard, decision-making (DM) in mathematical problem-solving plays a crucial role in shaping how students develop and express their creative thinking processes. DM influences strategy selection, idea organization and the way solutions are constructed. This study aims to describe how students' CT is manifested through their directive decision-making (DDM) style when solving open-plan geometry problems. This research employed a qualitative case study approach, involving 37 mathematics education students identified as having a DDM style from four universities in East Java, Indonesia. Data were collected through questionnaires, open-ended problem-solving tests, interviews and think-alouds to capture cognitive processes. Data were analyzed using the stages of data reduction, data display and conclusion drawing. Findings indicate that the DDM is characterized by a systematic, structured and rapid approach to problem-solving. Students with a DDM style demonstrate strengths in fluency, flexibility and detailed procedural elaboration. However, their originality tends to be limited, as they largely rely on standard and familiar procedures. Therefore, this study highlights the importance of examining how directed and efficiency-oriented thinking styles interact with CT processes that require flexibility, originality and exploration in the context of mathematics learning.

Keywords: Creative Thinking, Directive Style, Problem Solving, Mathematics.

Introduction

Creative thinking (CT) is a crucial competency in mathematics education, as it influences students' ability to solve non-routine problems. CT encompasses four dimensions: fluency, flexibility, originality and elaboration, which reflect the ability to generate ideas, shift strategies, produce unique solutions and develop ideas in depth (1). These dimensions are particularly relevant in geometry, where problems are open-ended and allow for multiple solution approaches (2). Students with higher CT abilities tend to generate alternative solutions and use diverse representations (3). Furthermore, integrating CT into mathematics learning enhances higher-order thinking skills and prepares students for 21st-century challenges (4). However, despite the widespread recognition of the importance of CT, various studies have shown that many students still struggle to maximize this ability. This is evident in students' tendency to remain trapped in procedural thinking patterns, making it difficult for them to generate diverse and innovative solutions (5, 6). In contrast, mathematical creativity is viewed as a crucial skill that can support in-depth understanding and problem-solving abilities. However, its conceptualization and measurement remain inconsistent across studies (7). This condition is further reinforced by mathematics learning practices in Indonesia, which tend to be procedurally oriented and teacher centered. As a result, the learning process emphasizes the final result rather than the student's thinking process, so that the development of mathematical creativity is less than optimal. Showed that elementary school students in Indonesia still experience difficulties in the aspect of novelty, even though they have demonstrated abilities in the aspects of fluency and flexibility in solving mathematical problems (8). In addition, other studies have revealed that students' mathematical CT abilities are generally in the moderate category and tend to be dominated by certain indicators, such as elaboration, while the aspect of originality is still relatively low (9). This indicates a gap between the

(Received 03rd April 2026; Accepted 23rd June 2026; Published 11th July 2026)

demands of the curriculum that emphasizes Higher Order Thinking Skills (HOTS) and learning practices in the field.

In this context, decision-making (DM) is a fundamental cognitive process involving the selection of the best alternative based on evaluating information, risks and consequences. DM style reflects individuals' tendencies in decision situations, such as directive, analytic, conceptual and behavioral styles, each contributing differently to decision quality and performance (10, 11). In education, these styles influence how students solve problems, organize information and regulate their thinking (12). They also affect how students explore solutions, thereby impacting the quality of their understanding (13). Therefore, understanding DM styles is essential for developing adaptive and reflective learning strategies.

Directive decision-making (DDM) is characterized by a preference for structure, speed and efficiency in processing information and determining actions. Individuals with a DDM style rely on clear procedures, rules and prior experience to make decisions quickly. This orientation has implications for CT, particularly in problem-solving. Structured and efficient characteristics can enhance fluency, as individuals can quickly generate ideas based on existing schemas (14). However, reliance on familiar strategies can limit flexibility and originality, as individuals are less likely to explore alternative approaches (15, 16). Compared to other styles, analytic and conceptual styles emphasize deeper reasoning and exploration of alternatives, while the behavioral style focuses on interpersonal aspects (17). In contrast, the directive style prioritizes efficiency and familiar procedures, making it suitable for mathematics learning that requires systematic problem-solving, although it may limit strategy diversity.

This is understandable because CT, characterized by the ability to generate various solutions (divergent thinking), correlates with certain DM styles, particularly the rational style, which significantly predicts creative performance (18). In other words, the integration of analytical and exploratory processes is key to producing innovative DM. In mathematics learning, DM is not only related to the selection of solution procedures, but also involves students' ability to explore various strategies and represent solutions flexibly.

Based on the above description, this study offers novelty by specifically examining the role of DDM style in the mathematical CT process of students in Indonesia, which has rarely been explored in the international literature. Most previous studies have focused on rational and intuitive DM styles in relation to divergent thinking and found that the rational style has a significant influence on creativity, while other styles have not shown a consistent contribution (19). Therefore, it is important to investigate how the directive style, characterized by a tendency to think quickly, be structured and be efficiency-oriented, interacts with CT processes that demand flexibility, originality and exploration of solutions in mathematics learning.

Furthermore, the novelty of this study also lies in the integration of the perspective of DM style and the mathematical CT process among Indonesian students in solving geometry problems that tend to be procedural. Previous research has shown that creativity in mathematics is highly dependent on students' ability to develop various solution strategies and relate them to complex problem contexts (20, 21). In addition, other studies have confirmed that the mathematical CT process involves systematic cognitive stages and is influenced by individual characteristics such as learning and cognitive styles (22). Thus, this study is expected to provide new contributions to revealing how the CT process with a directive style occurs in solving geometry problems, thereby producing a more comprehensive understanding of the interaction between DM and creativity in the context of mathematics learning in Indonesia.

Methodology

Research Design

This study used a qualitative case study design (23). This design was chosen because this study focuses on the "Case" of one student with a DDM style to explore in depth the critical thinking (CT) process when solving geometry problems (24). Using a case study approach, this research focuses on data depth through the triangulation of written work in solving the test, think-aloud protocols and interviews, as well as process tracing to elaborate fluency, flexibility, originality and elaboration of ideas in detail (25). This study adopts Torrance and Guilford's CT framework, which, in the context of geometry problem solving, is operationalized as: fluency (generating multiple strategies), flexibility (using multiple approaches), originality (generating unique solutions) and elaboration (developing solutions in detail and systematically). This adaptation aims to maintain the relevance of the concept of creativity in mathematics learning, particularly to support accuracy, variety of strategies and depth of thinking in the learning process.

Participants

The subjects of this study were mathematics education students in their second and fourth semesters from four universities in East Java Province, Indonesia. Respondents were selected based on their completion of relevant geometry courses related to the problems presented. The initial number of respondents was 130, who were then grouped based on their DM styles into four categories: directive [37], analytic [34], conceptual [33] and behavioral [26]. The subject selection flow is shown in Figure 1.

In Figure 1, subject selection begins with the stage of grouping students based on the results of the DM style questionnaire into four categories: directive, analytic, conceptual and behavioral. Next, in the second stage, the CT processes of students in each group were analyzed using indicators of fluency, flexibility, originality and elaboration. In the next stage, students who best represented the characteristics of their respective DM styles were given a problem-solving test to analyze and examine indicators of a clear CT process. From this selection process, five research subjects were obtained, consisting of one directive style student (D1), two analytic style students (A1 and A2), one conceptual style student (C1) and one behavioral style student (B1).

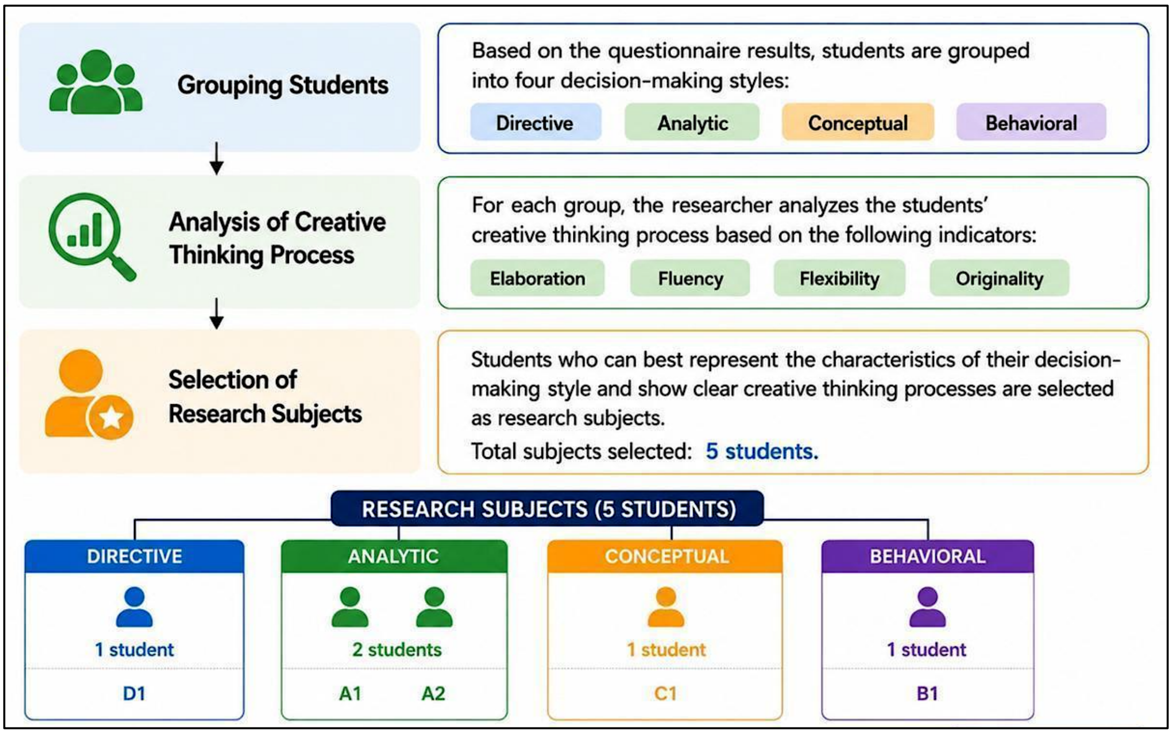

Figure 1: Subject Selection Stage

The subject was purposively selected as an information-rich case based on the criteria of consistent directive tendencies in willingness to participate, as well as the completeness and quality of written work and interview or think-aloud data (26). The directive style is considered unique and worth exploring further because of its emphasis on efficiency, structure and procedures, as well as its approach to exploring ideas in open-ended problems. This focus examines whether it facilitates or hinders creativity in the workplace. Therefore, focusing on a single subject provides the necessary analytical depth to fill the theoretical gap regarding the mechanisms of creativity in a directive style. Additionally, it provides an empirical foundation for broader studies in subsequent stages (27, 28).

Instruments

The research instruments consisted of the main and supporting instruments. The main instrument was the researcher, who was directly involved in the research process. The supporting instruments in this study consisted of three types: questionnaires, tests and interviews. The questionnaire used was adapted from a DM style instrument (29). The DM Style Scale consists of 20 statement items to identify students' DM style tendencies, including directive, analytic, conceptual and behavioral. Furthermore, the test instrument was in the form of mathematical problem-solving questions designed to reveal students' CT processes based on indicators of fluency, flexibility, originality and elaboration (30). Prospective subjects from the four groups of DM styles were identified based on the CT aspects: fluency, flexibility, originality and elaboration, with indicators developed as shown in Table 1.

Table 1: Aspects and Indicators of CT

Aspects of CT	Indicators
Fluency	Generating many ideas or solutions related to a problem without constraints.
Flexibility	Connecting different concepts or elements to find innovative solutions to problems.
Originality	Solving problems using a unique and different approach.
Elaboration	• It can clarify solutions in depth and detail. • Being able to explain ideas or solutions well, making them easily understood by others, both orally and in writing.

In addition, an in-depth interview guide was conducted using 16 questions aimed at further exploring students' thought processes, clarifying answers on the written test and strengthening the data through methodological triangulation. Thus, the three instruments complemented each other in obtaining comprehensive data on students' DM styles and CT processes. A semi-structured interview guide and think-aloud recordings were used as research instruments. An open-ended problem-solving test was used to explore students' CT abilities, as this test encourages subjects to find not only a single correct answer but also various alternative solutions. This test was validated by two expert lecturers in mathematics education from Malang State University and in consultation with the research team. The interview guide was developed through discussions with the research team to further explore the participants' CT processes in solving test problems and to ensure alignment with the research objectives.

Data Analysis

Data analysis in this study was conducted using a qualitative approach through the stages of data reduction, presentation and conclusion drawing. Data were obtained from written tests, think-alouds and interviews and analyzed to identify students' CT processes based on indicators of fluency, flexibility, originality and elaboration. The think-aloud method was used to capture cognitive processes directly, while interviews served to deepen and clarify these findings. To increase the validity and credibility of the data, this study applied method triangulation by combining various data collection techniques to minimize bias and produce a more comprehensive understanding of the phenomenon under study (31). Data analysis was conducted iteratively until a comprehensive understanding was obtained regarding the relationship between DM styles and CT processes in mathematics learning.

Results

The research findings indicate that the DDM style can be developed in the context of CT to solve open-ended problems in plane geometry. The exploration of the CT process in the subject with a DDM style is presented as follows: Description of CT Based on the DDM Style.

Understanding the Problem

D1 solved the problem by reading the test sheet and then writing down the known and asked information, namely, a rectangle with a length of 20 cm and a width of 12 cm. D1 also wrote down the questions asked, namely, a) draw two solutions and b) calculate the area. D1 represents the known and asked information in a verbal representation. This is also reinforced by the answer sheet written by D1 in Figure 2.

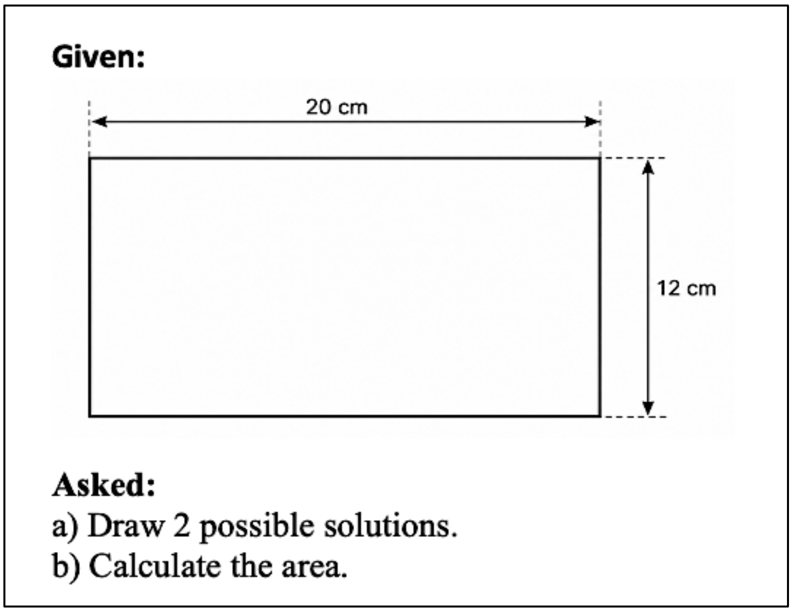

Figure 2: Answer D1 in Understanding the Problem

The answer to D1, shown in Figure 2, is explored through think-aloud as follows. During the think-aloud session, D1 read the problem statement and stated that an art teacher wanted to create a rectangular mosaic measuring 20 cm in length and 12 cm in width, consisting of six different geometric shapes. While opening the answer sheet and beginning to write, D1 identified the information provided in the problem, namely the dimensions of the rectangle. D1 further explained that the task required drawing two possible mosaic designs and calculating the area of each geometric shape contained within the rectangle.

Next, the researcher interviewed D1 to explore his understanding of this problem. To further explore D1's understanding of the problem, the researcher conducted an interview. D1 explained that when first reading the problem, the initial idea that came to mind was to draw a rectangle and divide it into six plane shapes. When asked about the actual question being posed, D1 stated that the task required calculating the area and sketching the mosaic. After being prompted to review the problem once more, D1 identified the specific requirements of the task, namely that each geometric shape must have a different shape and area and that all shapes must completely cover the rectangle without leaving any gaps or overlaps.

This demonstrates that D1 can understand problems directly and in a structured manner, consistent with the characteristics of the directive style. D1 not only identified explicit information but also grasped the key constraints. The resulting verbal representation reflects a good initial conceptual understanding, although it remains procedural. This process is supported by a directive style, which is the tendency to identify information quickly and directly to the core of the problem.

Devising a Plan

In the planning stage, D1 represents a rectangle in a pictorial representation shown in Figure 3. D1 draws a rectangle as a basic shape with its length pointing to the side, then divides the rectangle into six different geometric shapes, starting from the simplest shapes, such as rectangles and squares, then continuing to other shapes, such as triangles and trapezoids. D1 produces three solutions with different arrangements.

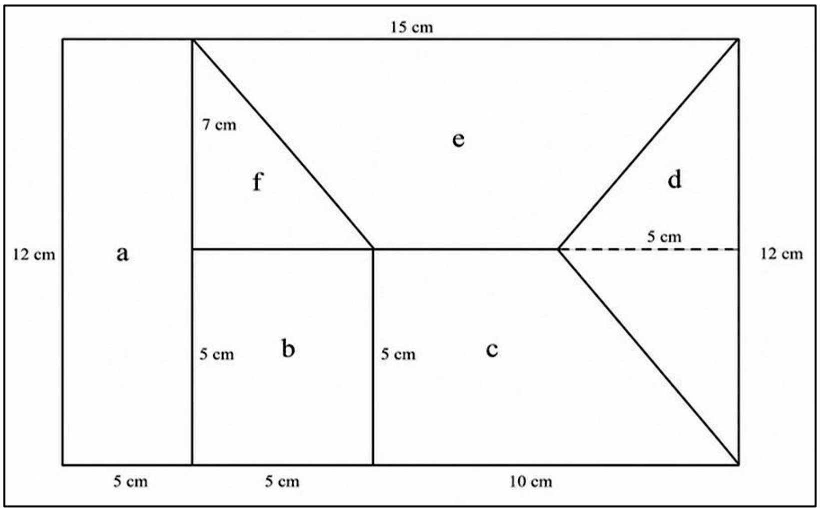

Figure 3: Visual Representation of D1 in Solution 1

For the first solution in Figure 3, D1 draws a rectangle with a length of 20 cm to the side and a width of 12 cm to the side. The first shape is a rectangle on the left side with a length of 12 cm and a width of 5 cm. The second shape is a square with a side length of 5 cm. The third shape is a right-angled trapezoid at the bottom right with a length of 10 cm for the bottom side, 5 cm for the top side and 5 cm for the height. For the first solution in Figure 3, D1 draws a rectangle with a length of 20 cm to the side and a width of 12 cm to the side, the first shape is a rectangle on the left side with a length of 12 cm and a width of 5 cm. next to it is the second shape which is a square with a side length of 5 cm, the third shape which is a right-angled trapezoid at the bottom right with a length of 10 cm for the bottom side, 5 cm for the top side and 5 cm for the height. On the far-right side, there is a fourth shape, an isosceles triangle with a base of 5 and a height of 12 cm. At the top center, there is a fifth shape, an isosceles trapezoid with a top side of 15 cm, a bottom side of 5 cm and a height of 7 cm and the sixth shape, a right-angled triangle at the top left with a base of 5 cm and a height of 7 cm.

For the second solution in Figure 4, D1 draws a rectangle with a length of 20 cm pointing downwards and a width of 12 cm. The first figure is a rectangle at the bottom with a length of 12 cm and a height of 5 cm. Above it is the second figure, a square with a side length of 6 cm. On the bottom right side is the third figure, a right triangle with a base of 6 cm and a height of 6 cm. Above the triangle is the fourth figure, an arbitrary triangle with a height of 15 cm and a base of 6 cm. The fifth figure, a parallelogram with a base of 3 cm and a height of 9 cm, is on the top left. The sixth figure, a right trapezoid at the top right, has a top side of 9 cm, a bottom side of 3 cm and a height following the height of the top, which is 9 cm.

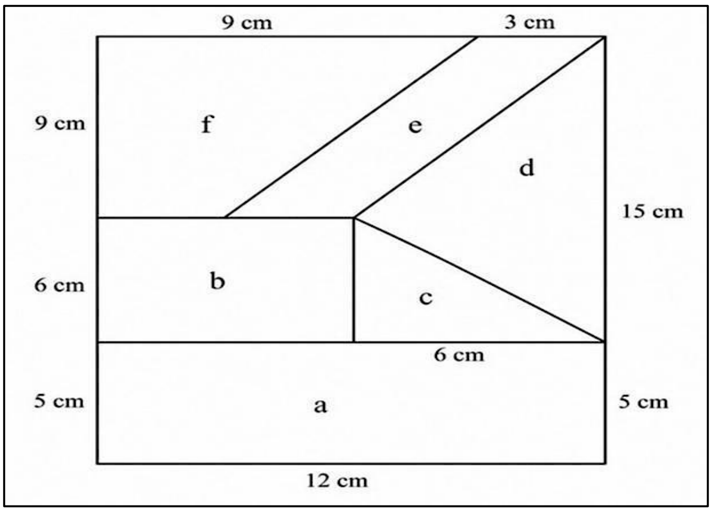

Figure 4: Visual Representation of D1 in Solution 2

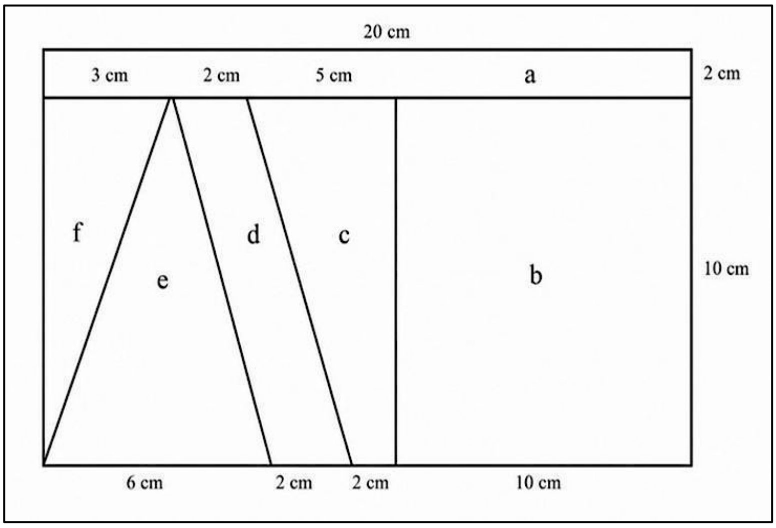

Figure 5: Visual Representation of D1 in Solution 3

For the third solution in Figure 5, D1 draws a rectangle with a length of 20 cm and a width of 12 cm. At the top was the first shape, a rectangle with a length of 12 cm and a width of 2 cm. Next to it was the second shape, a square with a side length of 10 cm. The third shape, a right-angled trapezoid, is at the bottom right with a bottom side length of 2 cm, a top side length of 5 cm and a height of 10 cm. After that, there is the fourth shape, a parallelogram with a base of 2 cm and a height of 10 cm. Next to it is the fifth shape, a triangle with a base side of 6 cm and a height of 10 cm. The sixth shape, a right-angled triangle, is on the far left, with a base of 3 cm and a height of 10 cm.

The researcher interviewed D1 to explore how he devised a plan to solve the problem. The researcher interviewed D1 to explore how he devised a plan to solve the problem. During the interview, D1 explained that the process began by drawing a large rectangle. He then created another rectangle on the left side and divided the remaining area into five additional plane shapes, starting with a simple shape such as a square. When asked why the second shape was a square, D1 stated that he preferred to begin with the simplest shape and then proceed to other shapes, including a right-angled trapezoid and a parallelogram.

This strategy demonstrates D1's practical and efficient approach, a hallmark of the directive style, beginning with familiar shapes to simplify the process. This stage demonstrated fluency through the large number of solution ideas generated (three variations). Furthermore, flexibility is evident in the changes in the orientation and shape combinations within each solution. However, D1's flexibility remains at the level of structural modification, not a change in conceptual approach, as evidenced by the strategy of starting with the simplest and most familiar shapes for efficiency. Table 2 describes the solution forms and strategies used by D1 in solving the problem.

Table 2: Solutions and Strategies

Solutions	Description of the Strategy	Strategy Categories
I	The rectangle is divided into several sub-geometrical shapes, such as rectangles, squares, right triangles, isosceles triangles, parallelograms and trapezoids.	Spatial Visualisation
II	Area Calculation Using the Length × Width Formula, including the area calculation for other square-shaped figures.	Numerical Calculation
III	A new combination of geometric shape divisions is generated.	Shape Reorganisation

Carrying Out the Plan

In the implementation stage, D1 applies the formula for the area of a flat shape procedurally and adds up the area of all shapes inside the rectangle to adjust it to the area of the rectangle. D1 contains the variable symbols p, l, s, a, b and t, which each represent length, width, side, upper base, lower base and height. D1 calculates the area of each shape using the appropriate formula. The implementation of the problem-solving plan is represented algebraically, as shown in Figure 6.

Figure 6 shows the algebraic representation of D1 in Solution 1. D1 writes down what is already known from the problem and provides general geometric area formulae (L). The first section was a rectangle with a length of 12 cm and a width of 5 cm. The area was calculated using the formula length × width, resulting in 60 cm^2. The second section was a square with a side length of 5 cm. The area was calculated using the formula side × side, resulting in 25 cm^2. The third section was a right-angled trapezoid with parallel sides measuring 5 and 10 cm and a height of 5 cm. The area was calculated using the formula ½ × (number of parallel sides) × height, resulting in 37.5 cm^2. The fourth section was an isosceles triangle with a base of 12 cm and a height of 5 cm. The area was calculated using the formula ½ × base × height, resulting in 30 cm^2. The fifth section was an isosceles trapezoid with parallel sides measuring 5 and 15 cm and a height of 7 cm. Using the formula for the area of a trapezoid, the result is 70 cm^2. Finally, the sixth section was a right triangle with a base of 5 cm and a height of 7 cm. The area was calculated using the formula ½ × base × height, resulting in 17.5 cm^2.

Solutions 2 and 3 were like the first solution. This stage demonstrated that D1 possessed strong procedural abilities, consistent with his directive character, which prioritizes precision. The ability to quickly correct errors demonstrates a good cognitive control. However, the strategies used are still conventional in nature. This stage demonstrated strong elaboration, as D1 was able to explain the calculation steps in detail and systematically. However, the originality aspect remains limited because the strategies used are procedural and general.

Solution 1

a. Rectangle

$$p = 12, \quad l = 5$$
$$L = p \times l = 12 \times 5 = 60\ cm^2$$

b. Square

$$s = 5$$
$$L = s^2 = 5^2 = 25\ cm^2$$

c. Right trapezoid

$$a = 5, \quad b = 10, \quad t = 5$$
$$L = \frac{1}{2} \times (a + b) \times t = \frac{1}{2} \times (5 + 10) \times 5 = 37.5\ cm^2$$

d. Isosceles triangle

$$a = 12, \quad t = 5$$
$$L = \frac{1}{2} \times a \times t = \frac{1}{2} \times 12 \times 5 = 30\ cm^2$$

e. Isosceles trapezoid

$$a = 5, \quad b = 15, \quad t = 7$$
$$L = \frac{1}{2} \times (a + b) \times t = \frac{1}{2} \times (5 + 15) \times 7 = 70\ cm^2$$

f. Right triangle

$$a = 5, \quad t = 7$$
$$L = \frac{1}{2} \times a \times t = \frac{1}{2} \times 5 \times 7 = 17.5\ cm^2$$

Figure 6: Algebraic Representation of D1 in Solution I

$$\text{Area of the rectangle } (L) = 60 + 25 + 37.5 + 30 + 70 + 17.5 = 85 + 55 + 100 = 240\ cm^2$$

Figure 7: D1's Answer in Rechecking Solution 1

Looking Back

The re-examination stage of D1's problem-solving process did not involve a spontaneous, thorough inspection, but rather after being asked to do so. He added up the entire area of the shape to ensure it matched the total area of 240 cm^2, as seen in Figure 7.

Figure 7 shows D1 rechecking the area of rectangle (L) by adding the areas of each plane figure, namely 60 + 25 + 37.5 + 30 + 70 + 17.5. The addition was performed in stages, namely 85 + 55 + 100 = 240 cm^2. Figure 7 shows further elaboration, namely, the ability to verify the results by comparing the total areas.

However, the reflection process remains unsystematic and not independent, so the creative aspect at this stage has not developed optimally yet. This indicates that D1's reflection process was still reactive and not self-initiated. His directive style tends to focus on quick completion, so the evaluation stage receives less attention than it should. Nevertheless, S1 can still be verified correctly when directed.

Table 3: Brief Evidence of Subject D1

Indicator	Brief Evidence	Assessment
Fluency	Three different solutions were generated: A (spatial visualization and shape division), B (area calculation using formulas) and C (repartition/recombination of shapes).	High
Flexibility	Switching strategies and representations: shape orientation, rotation, adaptation of parallelogram selection for the remaining space, layered decomposition.	Medium
Originality	A combination of shapes and unique orientations in each solution, without repeating division patterns; shape set variation (square, triangle, trapezoid and parallelogram).	Low
Elaboration	Detailed procedure description, total area verification and consistent think-aloud/interview process.	High (justification)

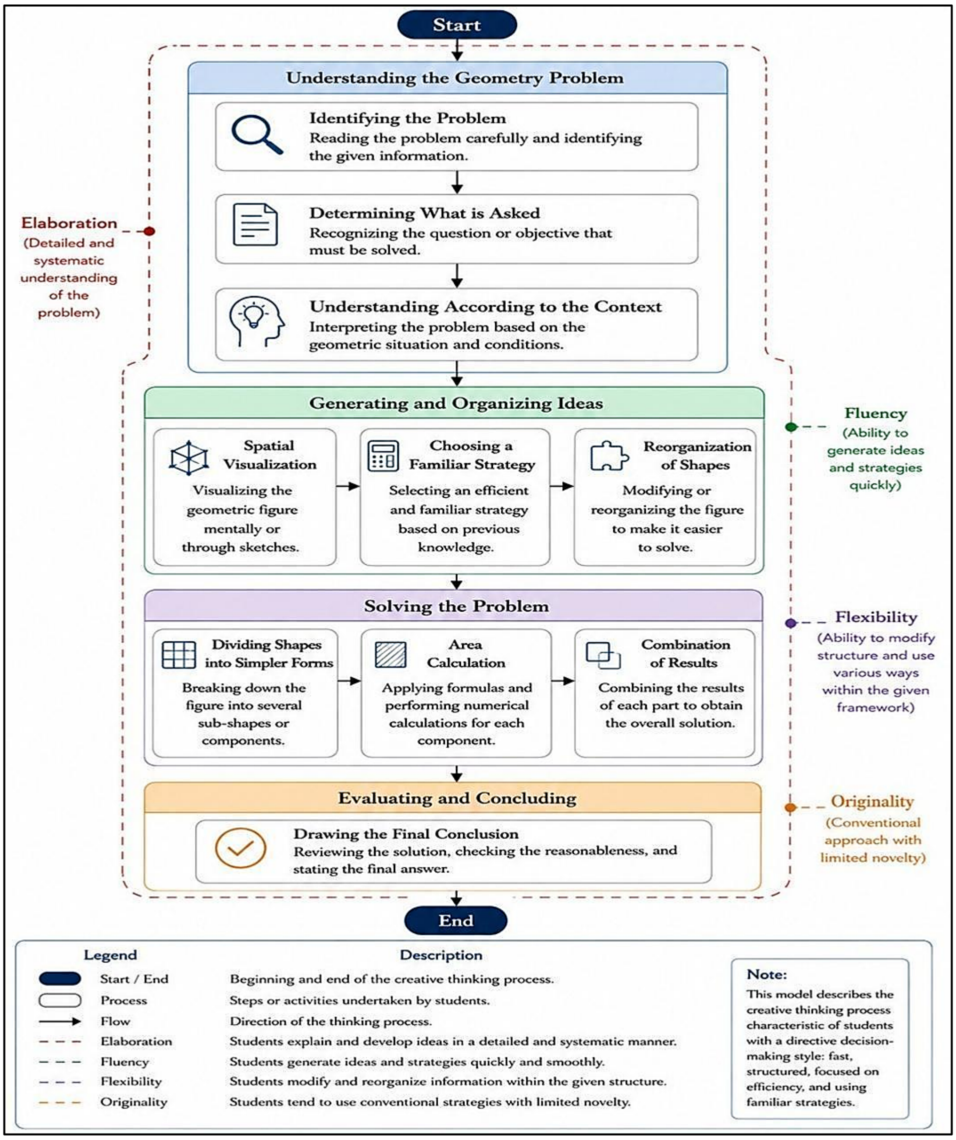

Figure 8: CT Process of D1

Overall, the CT D1 process with the DDM style at the problem-solving stage and CT aspects shows that fluency appears dominant at the problem understanding and planning stage, characterized by the ability to produce three solutions quickly, but tends to be the same. Flexibility is observed at the planning stage through limited variations in strategies regarding the arrangement and orientation of buildings and the use of more general approaches. Originality is observed because of the variety of shapes and arrangements. However, the ideas used are still based on general concepts commonly used in geometry because they prioritize certainty over novelty. Elaboration appears strong at the implementation and verification stages through detailed and systematic descriptions of steps, but is still procedural.

The DDM style fosters efficient, structured and results-oriented CT, with strengths in ideational fluency and procedural elaboration. However, this style also limits broader idea exploration and in-depth reflection, resulting in the under-development of flexibility and originality. D1 demonstrates that the directive style supports a rapid and systematic problem-solving process and can generate multiple valid solutions. However, the resulting creativity tends to be adaptive. A concise comparison of the four indicators for D1 is presented in Table 3 and the directive thinking process flow is shown in Figure 8.

Discussion

Subjects with a DDM style demonstrate an efficient, systematic CT process oriented toward accuracy and speed of solution. In this context, mathematical creativity is not always manifested through a broad exploration of ideas but also through precise and controlled strategic management. These findings reinforce the notion that creativity is contextual and influenced by an individual's cognitive style, with a directive style emphasizing efficiency, decisiveness and the use of validated procedures (32).

At the problem understanding stage, the subjects demonstrated the dominance of fluency, flexibility and expansion as the initial foundation of CT. The ability to identify information quickly and completely reflects high fluency, which contributes to successful strategy development (33). In addition, the ability to interpret problem constraints into operational forms indicates cognitive flexibility, which is important in mathematical creativity (34, 35). Information-organizing activities also demonstrate the role of expansion as an initial structure for reducing ambiguity (36).

In the planning stage, the four components of creativity emerge in a more integrated way. Subjects can generate several alternative solutions (fluency), adapt strategies (flexibility) and develop ideas through gradual modifications (incremental originality) (37). Expansion is apparent through the preparation of detailed steps as the basis for strategy implementation (38, 39). Meanwhile, in the implementation and examination stages, creativity tends to shift towards proceduralism, with fluency and flexibility dominating in maintaining accuracy and correcting errors, while originality is relatively limited due to following standard procedures (40).

Overall, mathematical creativity in the directive style can be categorized as controlled creativity (41), which is a combination of fluency of ideas, adaptive flexibility, systematic elaboration and incremental novelty (42). This pattern shows that creativity does not always develop in a balanced manner but is influenced by the individual's cognitive style (43). Therefore, the directive style can be understood as a form of "**Directed Mathematical Creativity**" that is oriented towards efficiency, accuracy and cognitive control in solving mathematical problems. However, while DDM supports efficiency and rapid DM, these characteristics can be both strengths and limitations, being effective for time-constrained tasks but inhibiting deeper and more creative exploration. These findings align with previous research showing that rational, structured, or directive thinking styles contribute to certain creative performances but do not necessarily support all aspects of divergent thinking.

Conclusion

Subjects with a DM style tend to display systematic, structured work patterns and are oriented towards accuracy and speed of completion. At the problem-understanding stage, this style is strong in fluency because it can repeat the requirements completely, accompanied by flexibility when clarifying the meaning of the constraint "without gaps and overlaps" as a prerequisite for dividing areas. At the planning stage, directives also show strong elaboration through detailed and sequential plan sketches, whereas originality tends to emerge through modifications. At the implementation and re-examination stages, directives maintain fluency and flexibility when errors occur, but originality is relatively lower because the calculation execution follows standard procedures. Overall, directives are effective in producing valid and neat solutions, but the development of creativity can be directed towards expanding the space for exploring more authentic and legitimate ideas.

Implications for Mathematics Learning

Teachers can foster creativity in students using the DDM style by encouraging various problem-solving alternatives, using open-ended problems and providing stimuli that challenge their thinking patterns. Furthermore, future research should compare DDM with other DM styles and use a mixed-methods approach to examine the quantitative relationship between DDM and CT.

Limitations

This study had several limitations that should be considered when interpreting the results. First, the number of research subjects was limited. Second, the research context, which is limited to geometric mosaics, makes the results not necessarily applicable to other mathematics topics with varying levels of complexity.

Recommendations

Based on these limitations, several recommendations can be proposed for future research. First, it is important for subsequent studies to involve a larger number of participants with more diverse backgrounds to obtain a more comprehensive understanding of students' problem-solving abilities. Second, the application of mixed-methods approaches is suggested to enhance the depth and validity of research findings, as such approaches allow for a more holistic integration of quantitative and qualitative data. Third, future research may explore different mathematical topics or varied learning contexts to examine the consistency of students' thinking patterns in problem-solving. By addressing these recommendations, future studies are expected to provide broader contributions to the understanding and development of students' mathematical problem-solving abilities.

Abbreviations

CT: Creative Thinking, D1: Subject Directive, DDM: Directive Decision-Making, DM: Decision-Making, HOTS: Higher Order Thinking Skills.

Acknowledgments

Thanks to Universitas Islam Malang, Universitas Muhammadiyah Malang, Universitas Negeri Malang and Universitas Insan Budi Utomo for granting permission and to the Mathematics Education Study Program Students who participated in this research.

Author Contributions

Fauziah: conceptualization, study design, Material preparation, data collection, data analysis, writing-first draft, Abd Qohar: Material preparation, data collection, data analysis, Santi Irawati: Material preparation, data collection, data analysis, review. All the authors have read and approved the final manuscript.

Conflict of interests

The authors declare no conflicts of interest.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Artificial Intelligence (AI) Assistance

The author used generative artificial intelligence (AI) tools to assist with language editing, grammar correction, clarity improvement and enhancement of the academic writing style of the manuscript. All revisions suggested by the AI tools were carefully reviewed, verified and edited by the author. The authors remain fully responsible for the content, accuracy and integrity of the manuscript. The author used generative artificial intelligence (AI) tools to assist in the creation of Figure 1 (Subject Selection Stage) and 8 (CT Process of D1). These figures were developed solely to enhance the visual presentation and understanding of the research procedures and conceptual processes described in this study. AI-generated figures do not constitute research data, findings, analyses, interpretations, or conclusions. All AI-generated visual content was carefully reviewed, verified and refined by the author to ensure its accuracy, relevance and consistency with this study.

Ethics Approval

All research procedures were conducted in accordance with ethical research principles, including respect for participants' rights, maintenance of data confidentiality and ensuring voluntary participation. Before the study, all participants were provided with an explanation of the study's purpose, procedures and potential risks and benefits. Consent for participation was obtained through an informed consent form signed by each participant. The confidentiality of the data obtained in this study was guaranteed and will be used solely for academic purposes. The researchers also ensured that there was no pressure or coercion during the participation process and gave the subjects the freedom to withdraw from the study at any time without any consequences.

Funding
This research was supported by the Study Completion Scholarship from the Endowment Fund for Education (LPDP), Ministry of Finance of the Republic of Indonesia.

References

1. Runco MA, Acar S. The standard definition of creativity. Creativity Research Journal. 2012;24(1):92–96. https://doi.org/10.1080/10400419.2012.650092
2. Levav-Waynberg A, Leikin R. The role of multiple solution tasks in developing knowledge and creativity in geometry. Journal of Mathematical Behavior. 2012;31(1):73–90. https://doi.org/10.1016/j.jmathb.2011.11.001
3. Sternberg RJ, Karami S. An 8P theoretical framework for understanding creativity and theories of creativity. The Journal of Creative Behavior. 2022; 56(1):55–78. https://doi.org/10.1002/jocb.516
4. Care E, Luo R. Assessment of transversal competencies: Policy and practice in the Asia-Pacific region. UNESCO Bangkok; 2020:1-30 ISBN. 978-92-9223-563-5. https://unesdoc.unesco.org/ark:/48223/pf0000246590
5. Dhungana S, Thapa R. Ways of Developing Creative Thinking and Reasoning of Students in Mathematics Learning. Mathematics Education Forum Chitwan. 2023;8(1):57–75. https://doi.org/10.3126/mefc.v8i1.60476
6. Joklitschke J, Rott B, Schindler M. Notions of Creativity in Mathematics Education Research: A Systematic Literature Review. International Journal of Science and Mathematics Education. 2022;20(6): 1161–1181. https://doi.org/10.1007/s10763-021-10192-z
7. Sipahi Y, Bahar AK. Mathematical creativity: A systematic review of definitions, frameworks and assessment practices. Education Sciences. 2025;15 (10):1-36. https://doi.org/10.3390/educsci15101348
8. Yayuk E, Purwanto, As'ari AR, Subanji. Primary school students' creative thinking skills in mathematics problem solving. European Journal of Educational Research. 2020;9(3):1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281
9. Shafa S, Zulkardi Z, Putri RII. Students' creative thinking skills in solving PISA-like mathematics problems related to quantity content. Journal Element. 2023;9(1):271-282. https://doi.org/10.29408/jel.v9i1.6975
10. Bavolar J, Kacmar P, Lovas L, Durbisona S. Decision-making style and goal striving. Journal of Behavioral Decision Making. 2023;37(1):1-29. https://doi.org/10.1002/bdm.2349
11. Zhu XS, Wolfson MA, Dalal DK, Mathieu JE. Team Decision Making: The Dynamic Effects of Team Decision Style Composition and Performance via Decision Strategy. Journal of Management. 2020;47(5):1-24. https://doi.org/10.1177/0149206320916232
12. Pathak S, Srivastava KBL, Dewangan RL. Decision styles and their association with heuristic cues and decision-making rules. Cogent Psychology. 2023;10 (1):1-13. https://doi.org/10.1080/23311908.2023.2166307
13. Newton C, Feeney J, Pennycook G. On the Disposition to Think Analytically: Four Distinct Intuitive-Analytic Thinking Styles. Personality and Social Psychology Bulletin. 2023;50(6):906-923. https://doi.org/10.1177/01461672231154886
14. Palmiero M, Nori R, Piccardi L, D'Amico S. Divergent thinking: The role of decision-making styles. Creativity Research Journal. 2020;32(4):323–332. https://doi.org/10.1080/10400419.2020.1817700
15. Saini G, Shabnam, Seema, Bhatnagar V. The Pattern of Executive Professionals' Thinking Styles in Relation to Cognitive Styles and Metacognition Skills. Cogent Psychology. 2022;9(1):1-17. https://doi.org/10.1080/23311908.2022.2068741
16. Huang NT, Chang YS, Chou CH. Effects of creative thinking, psychomotor skills and creative self-efficacy on engineering design creativity. Thinking Skills Creativity. 2020;37:100695. https://doi.org/10.1016/j.tsc.2020.100695
17. Curşeu PL, Schruijer S, Fodor OC. Decision rules, escalation of commitment and sensitivity to framing in group decision-making: An experimental investigation. Management Decision. 2016;54(7): 1649-1668. https://doi.org/10.1108/MD-06-2015-0253
18. Sassetti S, Cavaliere V, Lombardi S. The rhythm of effective entrepreneurs' decision-making process. The pathways of alertness scanning, search and cognitive style. A mediation model. International Entrepreneurship and Management Journal. 2022; 18:555-578. https://doi.org/10.1007/s11365-021-00759-1
19. Strang M, Miller M, Hill R, Elshaw J. Group decision performance: The Predictive Role of Decision-Making Styles and Cognition. Personality and Individual Differences. 2023;206:1-6. https://doi.org/10.1016/j.paid.2023.112114
20. Schoevers EM, Kroesbergen EH, Kattou M. Mathematical creativity: A combination of domain-general creative and domain-specific mathematical skills. Journal of Creative Behavior. 2020;54(2):242–252. https://doi.org/10.1002/jocb.361
21. Leikin, R. Evaluating mathematical creativity: The interplay between multiplicity and insight. Psychological Test and Assessment Modeling. 2013;55(4):385-400. https://www.psychologie-

aktuell.com/fileadmin/download/ptam/4-2013_20131217/04_Leikin.pdf.
22. Güner P, Erbay HN. Prospective mathematics teachers' thinking styles and problem-solving skills. Thinking Skills and Creativity. 2021;40:1-14. https://doi.org/10.1016/j.tsc.2021.100827
23. Yin RK. Case study research and applications: Design and methods (6th ed). SAGE; 2018:14-18. https://opac.atmaluhur.ac.id/uploaded_files/temporary/DigitalCollection/YTE3NDlmYTY0ZjE2MDA5ODE4NGI1Y2FhMjdkMjRmYWNkMDA2MTVhOQ==.pdf
24. Creswell JW, Creswell JD. Research design: Qualitative, quantitative and mixed methods approaches (3rd ed.). SAGE Publications; 2009:13-15. https://www.ucg.ac.me/skladiste/blog_609332/objava_105202/fajlovi/Creswell.pdf
25. Miles MB, Huberman AM, Saldana J. Qualitative data analysis (3rd ed.). SAGE; 2014:30-33. ISBN 978-1-4522-5787-7 https://www.metodos.work/wp-content/uploads/2024/01/Qualitative-Data-Analysis.pdf
26. Hidajat FA. Students' Creative Thinking Profile as a High-Order Thinking in the Improvement of Mathematics Learning. European Journal of Educational Research. 2021;10(3):1247–1258. https://doi.org/10.12973/eu-jer.10.3.1247
27. Mulia TC, Rahayu W. Creative Thinking in Mathematics. Prima: Jurnal Pendidikan Matematika. 2023;7(2):213-225. https://doi.org/10.31000/prima.v7i2.8528
28. Siswono TYE. Level of students' creative thinking in classroom mathematics. Educational Research and Review. 2011;6(7):548–553. https://academicjournals.org/article/article1379767432_Siswono.pdf.
29. Phillips-Wren G, Adya M. Decision making under stress: The role of information overload, time pressure, complexity and uncertainty. Journal of Decision Systems. 2020;29(sup1):213–225. https://doi.org/10.1080/12460125.2020.1768680
30. Runco MA, Acar S. Divergent thinking as an indicator of creative potential. Creativity Research Journal. 2012;24(1):66-75. https://doi.org/10.1080/10400419.2012.652929
31. Kinskey M. A Review of Using Think-Aloud Interviews and Cognitive Labs in Educational Research. The Qualitative Report. 2018;23(3):730-732. https://doi.org/10.46743/2160-3715/2018.3460
32. Meng KDL, Sau CL. Relationship of creativity and critical thinking to pattern recognition among Singapore private school students. The Journal of Educational Research. 2020;113(1):59-76. https://doi.org/10.1080/00220671.2020.1716203
33. Suherman S, Vidákovich T. Assessment of mathematical creative thinking: A systematic review. Thinking Skills and Creativity. 2022;44:1-13. https://doi.org/10.1016/j.tsc.2022.101019
34. Meier MA, Burgstaller JA, Benedek M, Vogel SE, Grabner RH. Mathematical Creativity in Adults: Its Measurement and Its Relation to Intelligence, Mathematical Competence and General Creativity. Journal of Intelligence. 2021;9(1):1-26. https://doi.org/10.3390/jintelligence9010010
35. Genc M, Akinci M, Karataş I, Çolakoğlu ÖM, Tığlı NY. From Thinking to Creativity: The Interplay of Mathematical Thinking Perceptions, Mathematical Communication Dispositions and Creative Thinking Dispositions. Behavioral Sciences. 2025;15(10):1-27. https://doi.org/10.3390/bs15101346
36. Lithner J. Principles for designing mathematical tasks that enhance imitative and creative reasoning. ZDM Mathematics Education. 2021;107(1):1–19. https://10.1007/s11858-017-0867-3
37. Elgrably H, Leikin R. Creativity as a function of problem-solving expertise: posing new problems through investigations. ZDM Mathematics Education. 2021;53(4):891–904. https://doi.org/10.1007/s11858-021-01228-3
38. Nazzal LJ, Kaufman JC. The relationship of the quality of creative problem-solving stages to overall creativity in engineering students. Thinking Skills and Creativity. 2020;38:1-15. https://doi.org/10.1016/j.tsc.2020.100734
39. Haavold PØ, Sriraman B. Exploring the relationship between mathematical convergent and divergent thinking. Thinking Skills and Creativity. 2026;62:1-19. https://doi.org/10.1016/j.tsc.2026.102226
40. Kirisci N, Sak U, Karabacak F. The effectiveness of the selective problem-solving model on students' mathematical creativity: A Solomon four-group research. Thinking Skills and Creativity. 2020;38:1-11. https://doi.org/10.1016/j.tsc.2020.100719
41. Weiss S, Steger D, Kaur Y, Hildebrandt A, Schroeders U, Wilhelm O. On the trail of creativity: Dimensionality of divergent thinking and its relation with cognitive abilities, personality and insight. European Journal of Personality. 2021;35(3):291–314. https://doi.org/10.1002/per.2288
42. Wu Y, Koutstaal W. Charting the contributions of cognitive flexibility to creativity: Self-guided transitions as a process-based index of creativity-related adaptivity. PLoS One. 2020;15(6):1-23. https://doi.org/10.1371/journal.pone.0234473
43. Hadar LL, Tirosh M. Creative Thinking in Mathematics Curriculum: An Analytic Framework. Thinking Skills and Creativity. 2019;33:1-13. https://doi.org/10.1016/j.tsc.2019.100585

How to Cite: Fauziah, Qohar A, Irawati S. How Directive Decision-making Style Shapes Indonesian Students' Creative Thinking Processes in Mathematics. Int Res J Multidiscip Scope. 2026;7(3):572-584.
DOI: 10.47857/irjms.2026.v07i03.012731