



Students' Creative Thinking in Semi-Complex Contexts: A Study of Mathematical Problem Construction

Rohmat Akbar Aji*, Rizqita 'alimatun Nisa', Turmudi, Elly Susanti

Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia

Email : ajiakbar2345i@gmail.com

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ABSTRACT

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*Corresponding Author

This study aims to describe the creative thinking abilities of students in the semi-complex category when posing mathematical problems, focusing on fluency, flexibility, originality, and elaboration. The research employed a descriptive qualitative approach involving Madrasah Aliyah students selected based on a creative thinking ability test. Data were collected through problem-posing tasks and semi-structured interviews to explore students' thought processes in depth. The findings reveal that students are able to generate several mathematical problems with varied structures and contexts, particularly demonstrating fluency and flexibility; however, they remain limited in terms of originality and depth of elaboration. The implications of this study highlight the need for instructional strategies that encourage deeper idea exploration, the use of open-ended stimuli, and reflective guidance to enhance students' creative thinking quality in mathematical problem posing. Additionally, continuous practice and supportive learning environments that promote collaboration, discussion, and real-world contexts are essential to foster more original ideas and richer elaboration, contributing to meaningful improvement in mathematics learning at the secondary education level.

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INTRODUCTION

Creative thinking has become a crucial competence in mathematics learning in the 21st century because modern societies increasingly demand individuals who can generate ideas, adapt to change, and solve complex problems. This study is important as it addresses how such competencies can be nurtured through mathematics education (Khofsah, 2025; Rahman, 2026; Shoha, 2026). The point is that education systems must cultivate creativity alongside content mastery. The reason lies in global transformations that prioritize innovation and problem-solving over routine procedures. Evidence from frameworks such as those proposed by Trilling and Fadel (2009) highlights that

creative and critical thinking are central to global competence development. Within the context of Kurikulum Merdeka, this emphasis becomes even more relevant, as students are expected to actively construct knowledge and apply it in meaningful contexts. Therefore, understanding how creative thinking develops, particularly in mathematical activities like problem posing, is essential. This study contributes by examining how students demonstrate creative thinking, providing insights that can inform teaching practices and curriculum development in broader educational contexts.

Despite its importance, the development of creative thinking in mathematics classrooms remains a significant challenge. Many students still rely on procedural knowledge and struggle to move beyond routine problem solving. The general problem lies in the limited opportunities for students to engage in tasks that promote creativity, such as generating their own mathematical problems (Hefniy & Alwahedi, 2025; Holidi, 2025; Manshur, 2026). This condition is often influenced by traditional teaching practices that emphasize correct answers rather than diverse thinking processes. As a result, students may lack confidence and experience in exploring multiple solution pathways or constructing original ideas (Hikmah & Mudarris, 2026; Kusumawati, 2025; Syafiih, 2025). Furthermore, assessment systems tend to prioritize standard solutions, which discourages experimentation and flexibility. This gap between expected competencies and actual classroom practices creates an urgent need to explore alternative instructional approaches. One such approach is problem posing, which encourages students to actively construct problems and think more deeply about mathematical concepts, thereby fostering creativity in a more meaningful and engaging manner.

In classroom practice, observable phenomena indicate that students' abilities in problem posing vary widely. Some students are capable of generating complex and contextually rich problems, while others tend to produce simple, routine, and predictable questions. This variation reflects differences in conceptual understanding, cognitive flexibility, and creative thinking skills. Teachers often report that only a small number of students demonstrate originality in their problem construction, while the majority rely heavily on examples provided in textbooks (Fauzi et al., 2025; Purwanto & Wafa, 2023; D. Susanti et al., 2025). Additionally, students categorized as semi-complex thinkers show an interesting pattern: they can generate logically structured and somewhat varied problems, yet they struggle to develop unique ideas or elaborate their reasoning in depth. This phenomenon suggests that there is a transitional stage in creative thinking development that requires further exploration. Understanding this group is important because it represents a large portion of students who have potential but need targeted support to reach higher levels of creativity in mathematics learning.

Previous studies have highlighted the importance of problem posing in enhancing mathematical creativity. Silver (1994) emphasized that problem posing activities can deepen conceptual understanding and increase student engagement. Similarly, Leung and Silver (1997) found that students who frequently engage in generating problems tend to exhibit more flexible and creative mathematical thinking (Abas & Kholidah, 2025; Eduzor, 2024; Venugopal et al., 2024). These studies establish problem posing as a powerful pedagogical strategy. Furthermore, research by Lin et al. (2012) introduced classifications of students' problem posing abilities, including the semi-complex category, which captures students who demonstrate moderate levels of creativity. While these studies provide valuable insights, they primarily focus on general patterns of creativity without deeply examining the specific characteristics of students within each category (Annisa et al., 2025; Ataman, 2024; Zahro, 2024). Consequently, there remains a need to explore how creative thinking indicators manifest in different levels of problem posing ability, particularly in semi-complex learners who occupy an intermediate position in the creativity spectrum.

In addition, theoretical frameworks of creative thinking, such as those proposed by Torrance (1974) and further elaborated by Krutetskii (1976), identify key indicators including fluency, flexibility, originality, and elaboration. These frameworks have been widely used to assess creativity in various contexts, including mathematics education (Khoiroh, 2025; Tohet, 2024). However, existing research often applies these indicators in a generalized manner without tailoring them to specific learning activities like problem posing. Moreover, there is limited research that integrates these indicators into an in-depth qualitative analysis of students' thinking processes, especially at the junior secondary school level. This creates a research gap in understanding how each indicator is expressed when students construct mathematical problems. Addressing this gap is important because it allows educators to design more targeted interventions that align with students' cognitive and creative development stages, ultimately leading to more effective learning experiences in mathematics classrooms.

The novelty of this study lies in its focus on semi-complex students and its detailed examination of their creative thinking characteristics in problem posing activities. Unlike previous studies that tend to generalize student abilities, this research specifically investigates how fluency, flexibility, originality, and elaboration are demonstrated within this particular group. This focus is important because semi-complex students represent a critical stage of development where targeted support can significantly enhance creativity. By using a qualitative descriptive approach, this study provides a deeper understanding of students' thought processes, rather than merely measuring outcomes. This approach offers new insights into how creativity can be nurtured through instructional strategies. Furthermore, the study contributes to the

development of more nuanced assessment tools for evaluating problem posing abilities, making it highly relevant for the implementation of competency-based curricula such as Kurikulum Merdeka.

Based on the identified gaps and phenomena, the research problem of this study is how semi-complex students demonstrate creative thinking when posing mathematical problems. The working argument is that these students exhibit strengths in fluency and flexibility but face challenges in originality and elaboration due to limited opportunities for exploratory learning. This assumption is grounded in both theoretical frameworks and observed classroom practices. Therefore, this study aims to provide a comprehensive description of these characteristics and to identify factors that influence their development. The contribution of this research lies in offering empirical evidence that can guide educators in designing learning environments that better support creative thinking. By highlighting the specific needs of semi-complex learners, this study also provides practical implications for improving teaching strategies, fostering innovation in mathematics education, and enhancing students' ability to construct meaningful and diverse mathematical problems.

RESEARCH METHODS

This study employed a qualitative case study design with a descriptive exploratory orientation to gain an in-depth understanding of students' creative thinking processes when posing mathematical problems, particularly those categorized as semi-complex (Mulyana et al., 2024; Niam et al., 2024; Okoko et al., 2023). A case study approach was chosen because it allows for a detailed and holistic exploration of a specific group within its real-life context, enabling the researcher to capture nuanced cognitive and behavioral patterns. This design is appropriate for examining complex phenomena such as creative thinking, which cannot be fully understood through quantitative measures alone. The descriptive exploratory nature of the study aims to identify and characterize patterns of fluency, flexibility, originality, and elaboration in students' thinking, as well as the factors influencing these processes, based on established frameworks by Guilford and Torrance.

The research was conducted at a public Madrasah Aliyah (Islamic senior high school) in Kediri Regency, Indonesia. This location was selected purposively due to its implementation of competency-based learning aligned with Kurikulum Merdeka, which emphasizes creative and critical thinking skills. Additionally, the school provided access to students with varying levels of creative thinking abilities, making it suitable for identifying semi-complex learners. The subjects of the study were three eleventh-grade students selected through purposive sampling based on the results of an initial creative thinking test and recommendations from the mathematics teacher. These students were

identified as representing the semi-complex category, characterized by moderate creative thinking abilities, enabling the researcher to focus on a specific developmental level that is often underexplored.

Data collection techniques included a combination of tests, semi-structured interviews, and direct observation (Danford, 2023; Hennink & Kaiser, 2022; Takona, 2024). The initial test was administered to all eleventh-grade students to assess their creative thinking abilities in mathematical problem posing, using indicators derived from Guilford and Torrance, namely fluency, flexibility, originality, and elaboration. The test consisted of open-ended, contextual tasks designed to encourage students to generate mathematical problems from given information. Following the test, semi-structured interviews were conducted with the selected subjects to explore their thought processes, reasoning strategies, and difficulties encountered during problem posing. Observations were also carried out to capture students' real-time behaviors and interactions while constructing and explaining their mathematical problems, providing additional contextual insights into their creative processes.

The data were analyzed using thematic analysis through four interconnected stages: data condensation, data display, and conclusion drawing/verification. Data condensation involved selecting, simplifying, and transforming raw data from tests, interviews, and observations into meaningful units. Data display was conducted by organizing the information into narrative descriptions, tables, and selected excerpts to facilitate interpretation. Finally, conclusions were drawn by identifying recurring patterns and themes related to students' creative thinking characteristics. To ensure the validity and trustworthiness of the findings, methodological triangulation was applied by comparing data from multiple sources and techniques. Source triangulation was also conducted through teacher confirmation and member checking with participants to verify the accuracy of interpretations, ensuring that the findings authentically reflected the students' experiences and perspectives.

RESULTS AND DISCUSSION

Portrait of Semi-Complex Students' Creative Thinking in Mathematical Problem Posing

This study aims to describe the creative thinking abilities of senior high school students categorized as semi-complex when engaging in mathematical problem posing. Based on creative thinking tests and in-depth interviews, three eleventh-grade students from a public high school in Kabupaten X were identified as meeting the semi-complex criteria according to indicators developed by Torrance, namely fluency, flexibility, originality, and elaboration. The findings reveal that these students demonstrate emerging creative capacities,

particularly in generating multiple ideas, yet their thinking remains constrained in terms of diversity, novelty, and depth (Listrianti & Cahyono, 2023; Wahid & Busthami, 2023). This condition reflects a transitional stage of creativity, where students begin to move beyond routine problem solving but have not yet achieved fully developed creative thinking. Such a profile highlights the importance of targeted pedagogical interventions to support the progression of students' creative competencies in mathematics learning contexts.

Patterns of Creative Thinking Performance in Problem-Posing Tasks

The results of the creative thinking test indicate that all three students were able to generate more than one mathematical problem from a given context, demonstrating a basic level of fluency. However, the problems produced tended to be structurally similar, differing only in numerical values or wording. In terms of flexibility, students showed limited variation, as most of the problems were confined to a single mathematical topic, such as algebra or geometry. This suggests that their ability to shift between different representations or conceptual approaches remains underdeveloped. Regarding originality, the majority of the problems were conventional and closely resembled textbook exercises, although some attempts were made to incorporate everyday contexts. In the aspect of elaboration, students provided minimal explanation of their reasoning processes, indicating a lack of depth in developing and justifying their ideas. These findings align with Torrance's framework, where semi-complex thinkers exhibit partial mastery of creative indicators but require further support to achieve higher levels of creative expression.

Insights into Students' Cognitive Processes Through Interviews and Observations

The interview and observational data provide deeper insight into how students construct mathematical problems. Students generally relied on modifying existing problems by changing numerical values or embedding them into simple narrative contexts. This strategy reflects a dependence on prior knowledge rather than the generation of entirely new ideas. Students also reported difficulties in creating unique problems, acknowledging that they were more accustomed to solving problems than formulating them. This habitual orientation toward procedural tasks limits their capacity for divergent thinking. Furthermore, their mathematical reasoning was predominantly procedural, focusing on formulas and computational steps rather than conceptual understanding (Athiyah, 2023; Sailin et al., 2024; N. Susanti et al., 2023). When

asked to elaborate on their problem-posing decisions, students offered brief and surface-level explanations, often justifying their choices based on familiarity or perceived relevance to examinations. Observational findings further revealed that although students could connect mathematical ideas to real-life situations, these connections were superficial and lacked deeper mathematical structure.

Interpreting Creative Thinking Through Torrance's Framework

From the perspective of creative thinking indicators proposed by Torrance (1974), the students demonstrate uneven development across dimensions. Fluency emerges as the strongest aspect, as students are capable of producing multiple ideas within a limited timeframe. However, as Torrance emphasizes, fluency alone does not guarantee creativity without diversity and depth. Flexibility remains limited, as students tend to remain within familiar conceptual boundaries, indicating difficulty in shifting perspectives. Originality is also underdeveloped, with students relying heavily on previously encountered problem types, suggesting limited exposure to open-ended and exploratory tasks. Elaboration, which involves expanding and refining ideas in detail, is the weakest aspect, as students' explanations lack analytical depth and mathematical justification. This pattern suggests that semi-complex students occupy an intermediate stage of creative development, where foundational skills are present but not yet fully integrated into sophisticated mathematical thinking.

Factors Influencing Semi-Complex Creative Thinking Development

Several factors were identified as influencing students' creative thinking abilities in problem posing. Learning experience plays a significant role, as students are more familiar with solving problems than generating them, making problem posing a cognitively demanding and unfamiliar task (Mustafa & Maulana, 2024; Rahmadan & Shudiq, 2024). Motivation and self-confidence also affect performance, with students often doubting their ideas and opting for safer, more conventional responses. Additionally, habitual thinking patterns shaped by traditional instruction limit students' engagement in divergent thinking processes. The learning environment further contributes to this issue, as classroom practices tend to emphasize procedural accuracy over conceptual exploration and creativity. These factors collectively create barriers that prevent students from fully developing their creative potential, particularly in tasks that require innovation and independent thinking.

Pedagogical Implications for Enhancing Creative Thinking in Mathematics

The findings of this study underscore the need for a shift in mathematics instruction toward approaches that actively promote problem posing and creative exploration. Teachers should design learning activities that encourage students to construct their own mathematical problems based on real-life contexts and personal experiences. Such practices can enhance both creative thinking and conceptual understanding. Instructional strategies such as open-ended tasks, problem-posing activities, and project-based learning can provide students with opportunities to explore multiple solutions and perspectives. Additionally, creating a supportive classroom environment that values originality and risk-taking is essential for fostering creativity. By providing continuous guidance and opportunities for reflection, educators can help students transition from semi-complex to more advanced levels of creative thinking, ultimately contributing to more meaningful and innovative mathematics learning experiences.

CONCLUSION

This study highlights several key findings regarding semi-complex students' creative thinking in mathematical problem posing. The most important insight is that these students possess an initial capacity for creative thinking, particularly in fluency, as they are able to generate multiple ideas; however, the ideas remain limited in variation, originality, and depth. Flexibility and originality are still weak, as students tend to remain within familiar topics and reproduce problem structures similar to those they have previously encountered. Elaboration is also underdeveloped, indicating that students' mathematical reasoning has not yet reached a deep conceptual level. A significant pedagogical implication drawn from this study is that students rely heavily on procedural knowledge and prior problem-solving experience rather than engaging in divergent thinking or creative exploration. This finding emphasizes the importance of integrating problem-posing activities and open-ended learning environments to foster more flexible and innovative mathematical thinking. The study contributes scientifically by providing a detailed qualitative description of semi-complex learners' creative thinking profiles, enriching existing literature on mathematical creativity by situating Torrance's indicators within the context of problem posing at the senior high school level.

Despite its contributions, this study has several limitations that should be acknowledged. First, the number of participants was limited to three semi-complex students, which restricts the generalizability of the findings. Second, the

study focused only on a single school context, meaning that variations across different educational environments were not captured. Third, the analysis relied primarily on qualitative interpretation, which, although rich in depth, may introduce subjectivity in data interpretation. For future research, it is recommended to involve a larger and more diverse sample to capture broader patterns of creative thinking in problem posing. Additionally, comparative studies between different levels of creative thinking ability could provide deeper insights into developmental trajectories. Future studies may also integrate mixed-method approaches or intervention-based designs to examine how specific instructional strategies, such as structured problem posing or project-based learning, can effectively enhance students' creative thinking skills in mathematics.

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