

Students' Creative Thinking in Geometry Problem Solving Across Adversity Quotient Levels

Athrieana Badi¹, Sonny Yalti Duma², Hersiyati Palayukan³, Suri Toding Lembang⁴

¹ Universitas Kristen Indonesia, Toraja, Indonesia; athrieanaabadi72@guru.sma.belajar.id

² Universitas Kristen Indonesia, Toraja, Indonesia; sonny_yalti@ukitoraja.ac.id

³ Universitas Kristen Indonesia, Toraja, Indonesia; hersiyati@ukitoraja.ac.id

⁴ Universitas Kristen Indonesia, Toraja, Indonesia; karitutususuri@gmail.com

ARTICLE INFO

Keywords:

creative thinking;
geometry problem solving;
adversity quotient (AQ);
qualitative case study;
mathematics education

Article history:

Received 2025-11-21

Revised 2026-05-05

Accepted 2026-05-30

ABSTRACT

Creative thinking is essential in geometry problem solving because students are required to generate ideas, use varied strategies, elaborate reasoning, and produce original solutions. However, students' creativity may be influenced not only by cognitive ability but also by non-cognitive factors such as Adversity Quotient (AQ). This study analyzes students' creative thinking in solving geometry problems across three AQ levels: Climber, Camper, and Quitter. This study employed a qualitative case study design involving three students selected purposively based on AQ categories. AQ levels were identified using a questionnaire adapted from Stoltz's framework. Data were collected through open-ended geometry problem-solving tasks and semi-structured interviews. Students' responses were analyzed using creative thinking indicators: fluency, flexibility, originality, and elaboration. Data analysis followed the Miles and Huberman interactive model, supported by thematic coding. The findings show clear differences across AQ levels. The high-AQ student demonstrated integrated creative thinking through multiple relevant ideas, varied strategies, detailed reasoning, and persistence in verifying solutions. The moderate-AQ student showed partial creative thinking, relying mainly on familiar procedures with limited flexibility and elaboration. The low-AQ student displayed minimal creative engagement, difficulty initiating problem solving, lack of alternative strategies, and low persistence when facing challenges. The study indicates that AQ shapes both persistence and the quality of students' creative thinking in geometry problem solving. Creative thinking should therefore be understood as an interaction between cognitive processes and affective resilience. Mathematics instruction should integrate open-ended tasks, reflective questioning, scaffolding, and supportive learning environments to foster both creativity and resilience.

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Corresponding Author:

Badi Athrieana

Universitas Kristen Indonesia Toraja 1; athrieanaabadi72@guru.sma.belajar.id

1. INTRODUCTION

Creative thinking is an essential competency in mathematics education because it enables students to generate various ideas, construct alternative strategies, and develop meaningful solutions to mathematical problems. In the context of 21st-century learning, students are expected not only to master procedures but also to think flexibly, critically, and creatively when facing unfamiliar situations. Geometry is one area of mathematics that strongly requires creative thinking, as students must interpret visual representations, identify relationships among shapes, imagine transformations, and justify their reasoning. Creative thinking in mathematics is commonly associated with four indicators: fluency, flexibility, originality, and elaboration. Fluency refers to the ability to produce several relevant ideas, flexibility concerns the use of different strategies, originality reflects the production of unique or uncommon responses, and elaboration involves the ability to explain and develop ideas in detail (Kim et al., 2023; Torrance, as cited in Kim et al., 2023).

Despite its importance, students' creative thinking in mathematics is often not optimally developed. Many students tend to rely on routine procedures and memorized formulas when solving geometry problems. This condition may limit their ability to explore alternative approaches or construct original solutions. Instruction that emphasizes single correct answers and fixed algorithms may reduce opportunities for students to engage in open-ended reasoning and mathematical exploration (Langi, 2021; Safitri, 2022). Previous research has also shown that students' limited exposure to non-routine and open-ended tasks can hinder the development of flexibility and originality in mathematical problem solving (Cai et al., 2022; Susanti et al., 2023). Therefore, mathematics learning needs to provide more opportunities for students to investigate problems, compare strategies, and explain their reasoning.

Creative thinking, however, is not shaped solely by cognitive ability. Non-cognitive factors such as persistence, confidence, motivation, and resilience also influence how students respond to challenging mathematical tasks. Students who are willing to persist when facing difficulty are more likely to explore different strategies and refine their solutions. Conversely, students who easily give up may fail to activate their creative potential, even when they possess adequate mathematical knowledge. This shows that creative thinking in problem solving involves both cognitive and affective dimensions (Efklides, 2020; Sternberg & Karami, 2021).

One non-cognitive factor that is relevant to students' problem-solving behavior is Adversity Quotient (AQ). AQ refers to an individual's capacity to face difficulties, overcome obstacles, and maintain effort when dealing with challenges (Stoltz, 1997). Stoltz classifies individuals into three categories: Climbers, Campers, and Quitters. Climbers have high AQ and tend to persist in solving problems, seek alternatives, and view challenges as opportunities. Campers have moderate AQ; they may continue working but often remain in their comfort zone and avoid deeper exploration. Quitters have low AQ and tend to withdraw or give up when facing obstacles. In mathematics learning, these differences may influence how students generate ideas, select strategies, and sustain reasoning during problem solving.

Several studies have examined students' creative thinking and AQ in mathematics education. Research has indicated that students with higher AQ generally demonstrate stronger persistence and better problem-solving engagement than those with lower AQ (Putra & Jailani, 2020; Rochmiyati & Widodo, 2020; Saputri et al., 2020). Other studies have shown that mathematical creativity is closely related to students' ability to generate multiple strategies, pose new ideas, and elaborate their reasoning (Beghetto & Kaufman, 2021; Leikin & Lev, 2021; Silver, 1997). However, many previous studies have focused primarily on measuring students' creative thinking outcomes or describing AQ levels separately. Limited attention has been given to how students' creative thinking processes in geometry problem solving differ across AQ categories through in-depth qualitative analysis.

This gap is important because understanding students' thinking processes can provide deeper insight into how resilience supports or constrains creativity. In geometry problem solving, students are often required to visualize situations, connect concepts, and justify solutions. These processes may be

difficult for students who lack persistence or confidence. Therefore, analyzing students' creative thinking across AQ levels can help explain how cognitive and affective factors interact during mathematical problem solving.

Based on this background, the present study aims to analyze students' creative thinking in solving geometry problems across three Adversity Quotient levels: Climber, Camper, and Quitter. Specifically, this study examines how students demonstrate fluency, flexibility, originality, and elaboration when solving geometry tasks. The findings are expected to contribute to mathematics education by highlighting the importance of integrating creative thinking development with resilience-building strategies in classroom instruction.

2. METHODS

2.1 Research Design

This study employed a qualitative case study design to examine students' creative thinking processes in solving geometry problems across different levels of Adversity Quotient (AQ). A case study design was considered appropriate because the study focused on obtaining an in-depth understanding of individual students' reasoning, strategies, persistence, and responses to mathematical challenges rather than producing statistical generalizations. Through this design, the study explored how students categorized as Climber, Camper, and Quitter demonstrated creative thinking indicators, namely fluency, flexibility, originality, and elaboration, during geometry problem solving.

2.2 Participants

The participants were three students selected purposively from a mathematics class at SMAS Kristen Rantepao. The selection was based on students' AQ levels, which were identified using an Adversity Quotient questionnaire adapted from Stoltz's framework. The questionnaire was used to classify students into three AQ categories: Climber, representing high AQ; Camper, representing moderate AQ; and Quitter, representing low AQ. From the questionnaire results, one student from each category was selected as the main research subject. The three participants were coded as AQT for the high-AQ student, AQS for the moderate-AQ student, and AQR for the low-AQ student.

The small number of participants was consistent with the purpose of a qualitative case study, which emphasizes depth of analysis and detailed interpretation of individual thinking processes. Each participant was selected because they represented a distinct AQ profile and were able to provide rich information related to the research focus.

2.3 Instruments

Two main instruments were used in this study: an Adversity Quotient questionnaire and geometry-based creative thinking tasks. The AQ questionnaire was adapted from Stoltz's framework and used to determine students' resilience in facing difficulties. The results of this questionnaire served as the basis for categorizing students into Climber, Camper, and Quitter groups.

The geometry tasks were designed in an open-ended format to elicit students' creative thinking. The tasks required students to interpret geometric information, develop solution strategies, explain their reasoning, and, where possible, propose alternative methods. The tasks were aligned with four indicators of mathematical creative thinking: fluency, flexibility, originality, and elaboration. Fluency referred to the ability to generate relevant ideas or responses; flexibility referred to the ability to use different strategies; originality referred to the ability to produce uncommon or unique solutions; and elaboration referred to the ability to provide detailed explanations and justifications.

Semi-structured interview guidelines were also prepared to explore students' reasoning processes more deeply. The interviews focused on how students understood the problems, generated ideas, selected strategies, responded to difficulties, and evaluated their answers.

2.4 Data Collection Procedures

Data were collected in several stages. First, the AQ questionnaire was administered to identify students' AQ levels. Based on the results, three students representing high, moderate, and low AQ categories were selected as research participants. Second, each participant was asked to solve open-ended geometry problems individually. Students' written responses were collected and analyzed as evidence of their creative thinking processes.

Third, semi-structured interviews were conducted after the problem-solving session. The interviews aimed to clarify students' written answers and reveal aspects of thinking that were not visible in their written work. During the interviews, students were asked to explain the reasons behind their strategies, describe difficulties they encountered, and reflect on whether they considered alternative solutions. The combination of written responses and interview data allowed the researcher to examine both the products and processes of students' mathematical thinking.

2.5 Data Analysis

The data were analyzed qualitatively using the interactive model of Miles and Huberman, consisting of data reduction, data display, and conclusion drawing. In the data reduction stage, students' written responses and interview transcripts were reviewed repeatedly to identify relevant information related to creative thinking and AQ characteristics. The data were then coded according to the four indicators of creative thinking: fluency, flexibility, originality, and elaboration. Additional attention was given to AQ-related behaviors, such as persistence, confidence, willingness to try alternative strategies, and responses to difficulty.

In the data display stage, each participant's problem-solving process was organized according to AQ category and creative thinking indicators. This enabled comparison across the three cases. The analysis focused on how each student generated ideas, selected strategies, explained solutions, and responded when encountering obstacles. In the conclusion-drawing stage, patterns were interpreted to describe the relationship between AQ levels and students' creative thinking processes in geometry problem solving.

2.6 Trustworthiness

Several strategies were used to ensure the trustworthiness of the study. Credibility was supported through triangulation of data sources, namely, students' written work and interview responses. The interview data were used to confirm, clarify, and deepen the interpretation of students' written solutions. Dependability was maintained by documenting the procedures of participant selection, data collection, coding, and interpretation. Confirmability was strengthened by grounding the findings in students' actual responses and by using clear indicators of creative thinking as the analytical framework.

2.7 Ethical Considerations

Ethical procedures were observed throughout the study. Participants were informed about the purpose of the research, the voluntary nature of their participation, and their right to withdraw at any stage. Confidentiality was maintained by using participant codes rather than real names. All data were used only for research purposes and were reported in a way that protected the identities of the participants.

3. FINDINGS AND DISCUSSION

3.1 Findings

This section presents the creative thinking profiles of three students representing different Adversity Quotient (AQ) levels: Climber, Camper, and Quitter. Since this study involved only one

participant from each AQ category, the findings are not intended to be generalized to all students. Instead, they provide an in-depth description of how each student demonstrated creative thinking in geometry problem solving based on the indicators of fluency, flexibility, originality, and elaboration.

Before the problem-solving task was administered, students' AQ levels were identified using an Adversity Quotient questionnaire adapted from Stoltz's framework. The questionnaire was used to classify students into three categories: high AQ or Climber, moderate AQ or Camper, and low AQ or Quitter. The classification was based on students' total AQ scores. Students with the highest score range were categorized as Climbers, students with moderate scores were categorized as Campers, and students with the lowest score range were categorized as Quitters. The questionnaire was reviewed by experts to ensure that the items reflected students' persistence, control over difficulties, endurance, and responses to obstacles in learning mathematics.

The geometry problem-solving task was designed in an open-ended format to elicit students' creative thinking. The task required students to identify relevant information, represent the problem geometrically, select an appropriate strategy, and explain the solution. Students' responses were analyzed using four creative thinking indicators. Fluency was shown when students could generate relevant ideas or identify useful mathematical information. Flexibility was shown when students used more than one strategy or shifted from one representation to another. Originality was identified when students produced uncommon, personal, or non-routine solution approaches. Elaboration was shown through detailed explanations, complete procedures, and justification of answers. The AQ questionnaire, geometry task, and interview guide were validated by mathematics education experts before being used in the study. The validators assessed content relevance, clarity of instructions, alignment with creative thinking indicators, and suitability for students' mathematical level.

3.1.1 High-AQ Student/Climber: Integrated Creative Thinking

AQT's written responses to the two geometry problems given are shown in Figure 1 below.

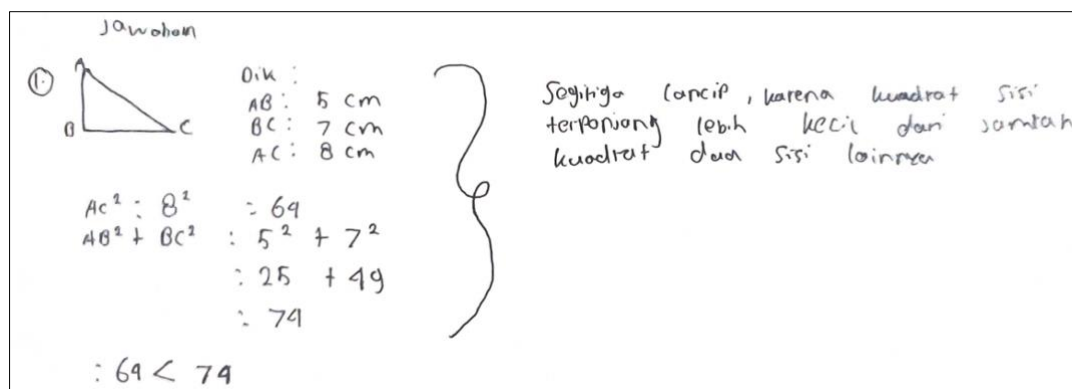


Figure 1. AQT's Written Responses

The high-AQ student, coded as AQT, demonstrated the most complete creative thinking profile among the three participants. In the written response, AQT began by drawing a right-triangle representation of the problem. The student identified the known information, namely the side lengths given in the problem, and then applied the Pythagorean theorem to determine the relationship among the sides. AQT wrote the calculation systematically and compared the obtained values to make a conclusion.

This response indicates fluency because AQT was able to identify relevant information from the problem and translate it into a mathematical representation. Elaboration was also visible in the student's step-by-step calculation and written explanation. The student did not only write the final answer but also showed how the answer was obtained. Evidence of flexibility appeared in the student's ability to move from a contextual statement to a geometric diagram and then to an algebraic calculation.

Although the originality indicator was not strongly visible, AQT showed a personal attempt to verify the answer rather than merely writing a direct formula.

The interview data supported this interpretation. When asked why the Pythagorean theorem was used, AQT explained, "Because the picture forms a right triangle, so I checked the sides using the formula. I wanted to make sure whether the length was correct." This statement shows that AQT understood the relationship between the visual representation and the mathematical procedure. It also suggests persistence, as the student tried to verify the result instead of stopping after identifying the formula.

Overall, AQT's response suggests that high AQ may support students' willingness to continue working, verify answers, and organize mathematical reasoning. In this case, persistence appeared to strengthen the student's fluency, flexibility, and elaboration in solving the geometry problem.

3.1.2 Moderate-AQ Student/Camper: Partial Creative Thinking

AQS's written responses to the two geometry problems given are shown in Figure 2 below.

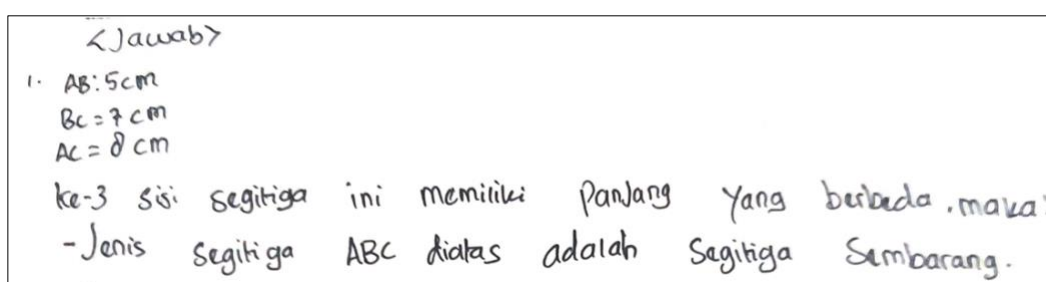


Figure 2. AQS's Written Responses

The moderate-AQ student, coded as AQS, showed a partially developed creative thinking process. In the written response, AQS was able to identify some relevant information and recognize a familiar geometric pattern. The student attempted to solve the problem using a known procedure, particularly by recalling the relationship among the sides of a right triangle. However, the response was shorter and less detailed than that of AQT.

AQS demonstrated basic fluency because the student could begin the solution and select information that was relevant to the problem. However, flexibility was limited because the student relied on one familiar strategy and did not attempt another method or representation. Elaboration was also weak because the student provided little explanation of why the selected strategy was appropriate. The student's work showed procedural knowledge, but the reasoning behind the procedure was not fully developed.

The interview confirmed this pattern. AQS stated, "I used the formula because I remembered this kind of triangle, but I was not sure how to explain it in another way." This statement indicates that the student could recall a known mathematical procedure but had difficulty extending or justifying the reasoning. When asked whether another strategy could be used, AQS answered, "Maybe there is, but I only know this way."

These findings suggest that AQS had enough persistence to complete the task but not enough confidence or flexibility to explore alternative strategies. The student's creative thinking was therefore partial: fluency was present, but flexibility, originality, and elaboration were limited. In this case, moderate AQ seemed to support task completion but did not strongly encourage deeper exploration.

3.1.3 Low-AQ Student/Quitter: Limited Creative Engagement

The low-AQ student, coded as AQR, demonstrated the most limited creative thinking profile. In the written response, AQR had difficulty identifying the relevant information and did not develop a complete solution strategy. The student's answer was incomplete and showed little evidence of mathematical reasoning. Unlike AQT and AQS, AQR did not construct a clear diagram, did not apply a complete procedure, and did not provide an explanation for the answer.

Based on the rubric, AQR showed low fluency because only a few relevant ideas were produced. Flexibility was not visible because the student did not attempt alternative strategies or representations. Originality could not be identified because the response did not show a unique or developed approach. Elaboration was also absent because the student did not explain the steps or justify the answer.

The interview data showed that AQR experienced difficulty and low persistence during the task. AQR stated, *"I was confused from the beginning. I did not know which formula to use, so I stopped."* When asked whether the student tried another way, AQR answered, *"No, because I thought my answer would be wrong."* These statements suggest that the student's difficulty was not only mathematical but also affective. The student's lack of confidence and persistence limited further engagement with the problem.

This finding indicates that low AQ may restrict students' opportunity to activate creative thinking. Since AQR stopped early, the student had little opportunity to generate ideas, test strategies, or elaborate reasoning. However, because this study involved only one student in the low-AQ category, this result should be interpreted as an individual case rather than a general conclusion about all low-AQ students.

3.1.4 Cross-Case Pattern

Across the three cases, the findings show a visible pattern in how AQ relates to students' creative thinking in geometry problem solving. AQT, the high-AQ student, showed a more integrated creative thinking process through relevant idea generation, visual representation, strategy use, verification, and explanation. AQS, the moderate-AQ student, showed partial creative thinking by using a familiar procedure but with limited flexibility and elaboration. AQR, the low-AQ student, showed minimal creative engagement because the student had difficulty initiating and sustaining the problem-solving process.

These findings suggest that AQ may influence not only students' persistence but also the quality of their creative thinking. However, the claim should be interpreted cautiously because the study used a small number of participants. The findings do not establish a broad causal relationship between AQ and creative thinking. Rather, they provide case-based evidence that students' resilience, confidence, and willingness to continue working may shape how they generate ideas, use strategies, and explain solutions in geometry problem solving.

3.2 Discussion

The findings indicate that students' creative thinking in geometry problem solving varies according to their Adversity Quotient (AQ) levels. The high-AQ student, categorized as a Climber, demonstrated a more integrated pattern of creative thinking than the moderate- and low-AQ students. In the written response, the student was able to identify relevant information from the geometry problem, construct a visual representation, apply the Pythagorean theorem, and compare the values obtained from the calculation. This process shows that the student did not merely use a memorized formula but attempted to connect the context of the problem with appropriate geometric reasoning. Such performance reflects fluency, flexibility, and elaboration, which are key indicators of creative thinking in mathematics (Kim et al., 2023; Torrance, as cited in Kim et al., 2023).

The Climber student's response suggests that high AQ supports both persistence and the organization of mathematical ideas. The student was able to continue working through the problem, verify the solution, and provide a written explanation of the reasoning process. This finding is consistent with Stoltz's (1997) theory, which describes individuals with high AQ as persistent, solution-oriented, and willing to face challenges. In geometry problem solving, persistence becomes important because students often need to interpret diagrams, identify relationships among elements, and select suitable strategies. The ability to sustain effort allows students to move beyond initial ideas and develop more complete reasoning. Therefore, high AQ appears to strengthen the activation of creative thinking

components, particularly when students encounter non-routine or context-based mathematical problems.

In contrast, the moderate-AQ student, categorized as a Camper, showed a partially developed creative thinking process. The student was able to recognize relevant information and begin the solution using a familiar procedure, but the response was limited in terms of strategy variation and explanation. This indicates that the student demonstrated basic fluency but had limited flexibility and elaboration. The student's tendency to rely on a single known method suggests dependence on procedural knowledge rather than deeper conceptual exploration. This pattern supports Stoltz's (1997) view that Campers may continue working on a task but often remain within their comfort zone. In mathematical creativity, this condition may restrict students from exploring alternative strategies or producing original responses.

The limited elaboration shown by the Camper student is important because creative thinking in mathematics requires more than generating an answer. Students need to explain why a strategy is appropriate, how mathematical relationships are formed, and whether other approaches are possible. Silver (1997) argues that mathematical creativity can be fostered through problem solving and problem posing that encourage multiple responses and reasoning. When students only follow one familiar procedure, their opportunity to develop flexibility and originality becomes limited. Thus, moderate AQ may be sufficient for task completion, but it may not be strong enough to support deeper creative engagement unless students receive appropriate instructional support.

The low-AQ student, categorized as a Quitter, demonstrated the weakest creative thinking profile. The student had difficulty initiating the solution, identifying relevant information, and developing a coherent strategy. There was little evidence of fluency, flexibility, originality, or elaboration. This finding indicates that low persistence may prevent students from entering the deeper stages of problem solving. When students give up early, they lose the opportunity to test ideas, revise strategies, and construct mathematical explanations. This aligns with Stoltz's (1997) description of Quitters as individuals who tend to avoid challenges and withdraw when facing difficulty.

This finding also confirms that creative thinking is not purely cognitive. Although mathematical knowledge is necessary, students also need confidence, resilience, and willingness to take intellectual risks. Sternberg and Karami (2021) emphasize that creativity involves complex interaction among personal, cognitive, and contextual factors. Similarly, Efklides (2020) notes that affective and metacognitive experiences influence how learners regulate their thinking during difficult tasks. In the present findings, the low-AQ student's lack of persistence limited the possibility of developing creative responses, even when the problem could potentially be approached through familiar geometric concepts.

Across the three cases, a clear pattern emerges: the higher the AQ level, the more complete the student's creative thinking process. The Climber student showed coordinated use of fluency, flexibility, and elaboration; the Camper student showed partial fluency with limited exploration; and the Quitter student showed minimal engagement. This pattern suggests that AQ shapes not only students' emotional response to difficulty but also the structure and quality of their mathematical thinking. In other words, resilience helps students sustain the cognitive effort needed for creative problem solving.

Pedagogically, these findings imply that mathematics instruction should develop creative thinking and resilience simultaneously. Teachers should provide open-ended geometry tasks that allow multiple strategies, encourage students to explain and compare solutions, and create a classroom environment where mistakes are treated as opportunities for learning. Reflective questioning, guided scaffolding, and problem-based learning may help students persist when facing difficulty and gradually develop more flexible thinking. As Beghetto and Kaufman (2021) argue, classroom contexts play an important role in supporting students' creative potential. Therefore, cultivating students' AQ is not separate from teaching mathematical creativity; both should be integrated in instructional design to help students become more persistent, reflective, and creative problem solvers.

4. CONCLUSION

This study concludes that students' creative thinking in geometry problem solving differs across Adversity Quotient (AQ) levels. The high-AQ student, categorized as a Climber, demonstrated an integrated creative thinking process through relevant idea generation, visual representation, strategy selection, solution verification, and detailed reasoning. The moderate-AQ student, categorized as a Camper, showed partial creative thinking by identifying known information and applying familiar procedures, but with limited flexibility, originality, and elaboration. Meanwhile, the low-AQ student, categorized as a Quitter, showed minimal creative engagement, difficulty initiating problem solving, weak strategy development, and low persistence when facing challenges. These findings indicate that creative thinking in geometry is not only influenced by cognitive ability but also by affective resilience, particularly students' willingness to persist, explore alternatives, and justify their reasoning. However, this study has limitations. The small number of participants and the use of one student to represent each AQ category limit the generalizability of the findings. In addition, the study was conducted in a specific school context and focused only on geometry problem solving, so the results may not fully represent students' creative thinking in other mathematical topics or learning environments. Future research is recommended to involve larger and more diverse participants, apply mixed-methods designs, and examine students' creative thinking across different mathematical domains. Further studies may also investigate the effectiveness of instructional strategies, such as open-ended problem solving, reflective questioning, and scaffolding, in improving both students' creative thinking and resilience.

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