Creative Thinking Ability of Mathematics Students in Solving Geometry Problems Viewed of Adversity Quotient

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Abstract
This study examines the creative thinking abilities of mathematics student teachers in solving geometry problems, analyzed through the lens of Adversity Quotient (AQ). The participants, categorized as climbers, campers, and quitters, displayed varying levels of creative thinking based on three indicators: fluency, flexibility, and novelty. Climber students achieved fluency and flexibility by producing multiple logos using two different methods but lacked novelty as their approaches relied on existing methods. Campers demonstrated flexibility by using two distinct approaches but failed to meet fluency and novelty criteria. Quitters only met the fluency indicator and were at the less creative level. None of the subjects fulfilled the originality indicator, highlighting a critical gap in creative thinking skills among the participants. These findings underline the importance of fostering creative thinking in mathematics education, especially for student teachers who will later nurture such skills in their students. Enhancing the quality of mathematics instruction by incorporating open-ended problems and promoting a culture of mathematical thinking is essential. This aligns with the educational aim to balance analytical and creative thinking as fundamental aspects of problem-solving in mathematics.
Keywords: creative thinking, geometry, Adversity Quotient, mathematics education

Introduction

Mathematics is often perceived as a rigid field filled with formulas that must be memorized, making it seem boring and even intimidating for many students (Mawardini and Ningsih 2022;Subekti 2012;Dewi and Lestari 2021). In fact, mathematics not only serves as a tool for solving calculations or everyday problems but also as a medium for developing logical and creative thinking skills (Umar and Ahmad 2019). In the context of mathematics education, creative thinking ability is a crucial aspect that needs to be fostered. Creative thinking enables students to discover innovative solutions to mathematical problems, which often require different approaches (Utami, Endaryono, and Djuhartono 2020;Sekar Ayu, Ilyas Moharom, and Sylviana Zanthy 2020;Rudyanto et al. 2019;Karim, Pasani, and Andriyani 2022), including in geometry, which demands visual imagination and deep conceptual exploration (Suryanti et al. 2023; Mas'udah et al. 2021).

Creative thinking ability in this study is measured based on three indicators: fluency, flexibility, and novelty (Silver 1997). Fluency refers to a student's ability to generate multiple ideas or solutions for a single problem, flexibility refers to their ability to solve problems using various methods, and novelty indicates their ability to produce unique and original ideas by examining multiple methods or solutions and then creating something different (Nugrahaeni, S'dijah, and Sisworo 2022). Unfortunately, the level of creative thinking ability among Indonesian students remains relatively low (Rahman 2012;Suparman and Luvy 2019). Based on previous surveys and studies, students often struggle to produce varied or innovative solutions when solving mathematical problems, especially in geometry, which requires high visual representation and analytical skills (Mas'udah et al. 2021; Murtafiah 2017; Gridos et al. 2022; Dewi and Lestari 2021). As a result, their ability to think creatively tends to stagnate (Wanelly and Fauzan 2020).

One of the factors that contribute to the level of creative thinking ability is Adversity Quotient (AQ) (Hidayat et al. 2018; Suhandoyo and Wijayanti 2016). AQ is a person's ability to face and overcome difficulties in life (Hidayat et al. 2018; Juwita, Roemintoyo, and Usodo 2020).AQ is classified into three categories, namely: quitters, who tend to give up when facing difficulties; campers, who stop at a certain point and are reluctant to try further; and climbers, who keep trying despite facing significant challenges (Wahyuningtyas, Suyitno, and Asikin 2020; Juwita et al. 2020). Students with high AQ (climbers) are more likely to show better creative thinking skills because they are able to persevere and find innovative solutions in dealing with mathematical problems, including geometry problems that are often considered complex and abstract (Wahyuningtyas et al. 2020; Hidayat et al. 2018).

In the context of mathematics learning, the role of teachers is crucial in enhancing students' creative thinking abilities while also taking into account their AQ (Murtafiah 2017b; Dewi and Lestari 2021; Umam and Yudi 2016; Wijayanto, Purwosetiyono, and Prasetyowati 2021). Teachers can employ instructional strategies such as open-ended questions to encourage students to explore various solutions (Murtafiah 2017b; Dewi and Lestari 2021; Umar and Ahmad 2019). Additionally, teachers should consider the differences in students' AQ to provide more tailored approaches that effectively support the development of their creative thinking abilities (Wijayanto et al. 2021; Nugrahaeni et al. 2022).

As an institution that produces future mathematics teachers, universities have a significant responsibility to instill an understanding of the importance of creative thinking abilities and Adversity Quotient in mathematics students (Nugrahaeni et al. 2022). Prospective teachers need to be equipped with creative thinking skills through challenging learning experiences, such as providing open-ended problems based on geometry. Geometry is chosen because it holds great potential for developing creative thinking skills. It allows students to visualize mathematical concepts through various approaches and solutions (Gridos et al. 2022). Through this topic, prospective teachers can be trained to integrate diverse ideas in solving problems, making them better prepared to face future teaching challenges (Nugrahaeni et al. 2022).

This study was conducted in the Mathematics Education Study Program (Tadris Matematika) at the Faculty of Tarbiyah, IAIN Madura, with the aim of describing the creative thinking abilities of prospective mathematics teachers in addressing geometry problems, viewed through the lens of Adversity Quotient (AQ). IAIN Madura is the only public university in Madura that offers the Mathematics Education Study Program. The presence of this program is expected to meet the needs of the Madura community for competent, innovative, and creative mathematics educators. As a newly established program, this study provides an initial contribution to assessing the quality of learning, particularly in the aspect of students' creative thinking abilities. The findings of this research are also expected to offer valuable input for prospective teachers and universities in designing effective teaching strategies to enhance creative thinking skills, considering AQ as one of the influential variables. Furthermore, the study may serve as a foundation for curriculum development tailored to the future needs of mathematics education.

This research is highly significant in the context of education in Madura, where the low quality of mathematics education and students' creative thinking skills represent major challenges requiring serious attention. Government policies such as the Kurikulum Merdeka emphasize the development of critical and creative thinking skills, but their implementation in areas with limited facilities and human resources, including teachers, still faces various obstacles. By focusing on the creative thinking abilities of prospective mathematics teachers and considering Adversity Quotient (AQ) as a key factor, this study is expected to provide strategic solutions for building the mental resilience and creativity of future educators. The findings have the potential to contribute significantly to the long-term improvement of mathematics education quality in Madura.

Method

This study uses a qualitative descriptive method, because it aims to provide a detailed depiction of the creative thinking abilities of prospective mathematics teacher students based on their Adversity Quotient (AQ) in solving open-ended problems in geometry (Ruhansih 2017). The research was conducted on third-semester students of the Mathematics Education Study Program, Faculty of Tarbiyah, IAIN Madura, during the 2024/2025 academic year, who were studying geometry. The research population consisted of 25 prospective mathematics teacher students. From this population, three students were selected as research subjects based on their AQ category, having equivalent mathematical abilities and the same gender. These three students included: one climber student, one camper student, and one quitter student. Thus, the subject selection technique in this study utilized purposive sampling, which involves selecting subjects based on specific criteria (Sugiyono 2017).

Data collection was conducted using several instruments. The primary instrument in this research was the researcher themselves, supported by validated instruments from experts in the field, which included: Adversity Quotient questionnaire to classify students into the categories of quitters, campers, or climbers; Geometry Test consisting of open-ended questions to measure students' creative thinking abilities; Documents on students' basic mathematical abilities; An interview guide designed to explore aspects of fluency, flexibility, and novelty (Xu and Storr 2012).

This study employed technique triangulation to enhance data validity. The same data were obtained through various methods, namely tests, questionnaires, documents, and interviews. This approach aimed to ensure data consistency and provide a more comprehensive understanding. Consistent data from different methods were used to support the research findings (Nurfajriani et al. 2024; Ruhansih 2017; Sugiyono 2017).

Data from the test results, questionnaires, documents, and interviews were analyzed through three stages: data reduction, data display, and conclusion drawing. Data were reduced to identify information relevant to the indicators of creative thinking. The data were presented in the form of narratives, tables, and diagrams to facilitate the analysis of the relationship between AQ and creative thinking abilities (Ruhansih 2017).

Results and Discussion

Initially, an Adversity Quotient questionnaire was distributed to third-semester students in the Mathematics Education program. Based on the results, three students with different adversity levels (climber, camper, and quitter), the same gender, and equivalent mathematical abilities were selected as research subjects. These three subjects were given a geometry problem to solve within 45 minutes and participated in an interview. The test consisted of a single problem with questions designed to assess each indicator of creative thinking ability. The test problem is as follows:

Imagine you are tasked with creating a unique company logo that consists of a circle, a square, and an equilateral triangle. The circle has a diameter of 10 cm, the square has sides of 8 cm, and the equilateral triangle has sides of 6 cm.

Instructions:

- How would you arrange these three shapes into a visually appealing logo? Explain your design steps!
- Create another logo design different from the first one!
- Create a completely different logo from the previous designs!

The codes used in the interview are as follows:

Table 1. Codes Used in the Interview

No.	Codes	Description
1	Rxi	The i-th researcher question on AQ category subjects, where x denotes climber, camper, or quitter. Climber is coded L, camper is coded P, and quitter is coded Q.
2	Mxi	The code of the AQ category subject's answer to the i-th researcher's question in the interview. x denotes climber, camper, and quitter. Climber is coded L, camper is coded P, and quitter is coded Q.

Research Subject in the Climber Category (ML)

ML's response to solving the geometry problem can be seen in the following figure.

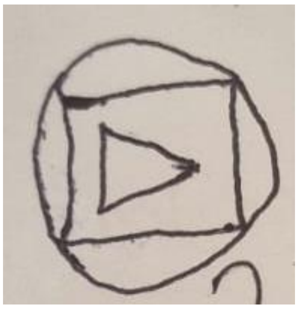

Figure 1. ML’s answer (Logo 1)

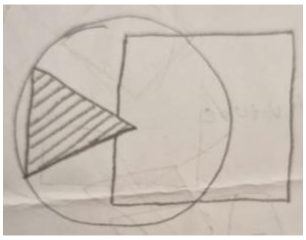

Figure 2. ML’s answer (Logo 2)

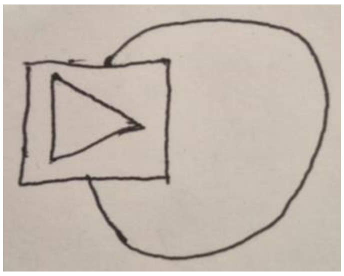

Figure 3. ML’s answer (Logo 3)

Based on ML's response, an analysis will be conducted using three indicators of creative thinking ability: fluency, flexibility, and novelty.

Fluency

Subject ML designed three different logos consisting of a circle, a square, and a triangle, with dimensions adhering to the specifications in the problem. In Logo 1, ML drew a triangle inside a square, which was enclosed within a circle. In Logo 2, ML drew a triangle inside a circle that intersected with a square. In Logo 3, ML drew a triangle inside a square, with part of the square overlapping with a portion of the circle. This indicates that ML fulfills the fluency component by presenting more than one logo while considering the elements of each geometric shape and their respective dimensions in forming the logos (Herawati 2023; Siswono 2018).

Flexibility

The first step ML took to solve the problem was identifying the given information and the question being asked. After recognizing that the largest shapes in descending order were the circle, square, and then the triangle, ML began visualizing how to arrange these shapes to resemble an object commonly seen in daily life, such as the YouTube logo, as shown in Figure 1. For the second logo, ML no longer focused on real-life objects but instead developed the first logo further by translating certain elements from Logo 1. ML shifted the positions of the circle and triangle in Logo 1 to the left, resulting in a logo similar to that shown in Figure 2. This approach aligns with the following excerpt from the interview conducted with ML.

RL.03 : How did you come up with the first logo?

ML.03 : *When I was drawing the first logo, I remembered the YouTube logo, ma'am. So, I drew the triangle inside the square like this. Then, because there needed to be a circular element, and the circle is the largest of the shapes, I added the circle like this, ma'am.*
RL.06 : *How did you come up with the second logo?*
ML.06 : *(Pauses briefly) Honestly, I was a bit confused, ma'am, because the dimensions were already fixed, and the logo had to be unique. So, for the second logo, I just shifted the circle and the triangle over here (pointing at the diagram), which made it look like this*

Based on the interview excerpt, ML was able to explain more than one idea or method for creating the logo while considering the components of each geometric shape and their respective dimensions in forming the logo. Thus, ML fulfills the flexibility component (Siswono 2018).

Novelty

After Figure 2 was created, ML imagined that if the two logos already formed were in motion, then Logo 2 would represent the transition before Logo 1. To create Logo 3, ML visualized the final transition after Logo 1 by shifting the circle in Logo 1 to the right. This is also consistent with the following excerpt from the interview with ML:

RL.08 : *Oh, I see. So, how did you come up with Logo 3?*
ML.08 : *From Logo 2, I started imagining if this logo was moving. There would be a transition process. Let's say Logo 2 represents the transition process before Logo 1, then I imagined the final transition would look like this logo. Since I imagined the transition moving to the right, for Logo 3, I pictured the circle rolling to the right, resulting in this.*
RL.10 : *Okay. If I gave you more time, could you think of another way to create a different logo?*
ML.10 : *Hmm, it depends on how much time, ma'am. Maybe if I had another half an hour, I could come up with one more, ma'am.*
RL.12 : *How would you create it?*
ML.12 : *Hmm, I'm not sure yet, ma'am.*

Based on Figure 1, Figure 2, Figure 3, and the interview excerpt, it can be seen that ML was able to create three different geometric logos but with similar approaches. Although ML was able to explain the creation of Logo 1 and Logo 3 using two different methods, for Logo 3, ML still employed the same idea or approach as in Logo 2, namely by performing a translation. Therefore, it can be concluded that ML does not yet fulfill the novelty indicator (Siswono 2018).

Research Subject in the Camper Category (MP)

MP's response to solving the geometry problem can be seen in the following figure.

Figure 4. MP’s answer (Logo 1)

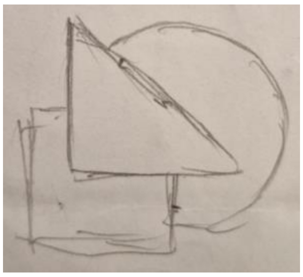

Figure 5. MP’s answer (Logo 2)

MP's responses to solving the geometry problem are analyzed based on three creative thinking indicators: fluency, flexibility, and novelty.

Fluency

MP, designed two unique and distinct logos composed of a circle, square, and triangle. In Logo 1, MP depicted a circle as the base of the logo. MP then illustrated the square's edges using dashed lines, focusing only on the square's sides within the circle, and positioned the triangle inside half of the circle. The dimensions of each element drawn align with the problem's specifications. In Logo 2, MP first drew the triangle, then added the square to the left of the triangle, positioning it below the triangle, and placed the circle to the right of the triangle, positioning it beneath the square. However, in Logo 2, the estimated sizes of the elements do not align with the problem's requirements, which state that the order of the elements by largest to smallest size is circle, square, and triangle. In Logo 2, MP depicted the triangle's size as larger or equal to the square's size. This shows that MP does not meet the fluency component, as only one logo adheres to the problem's specifications (Siswono 2018).

Flexibility and Novelty

The first step MP took to solve the problem was identifying that the logo must consist of different elements. MP then imagined a company logo and decided to use the circle as the base. MP thought about positioning the triangle and square according to their sizes to create an appealing logo. To enhance the visual appeal, MP depicted the square's edges using dashed lines, focusing only on the square's sides within the circle, resulting in Logo 1 (Figure 4). To create the second logo, MP arranged the three elements in a layered structure: the triangle in the front layer, the square in the middle layer, and the circle in the back layer. This aligns with the following excerpt from the interview with MP:

RP.03 : How did you create the first logo?
MP.03 : Here's how, ma'am. From the problem, we know there's a circle, square, and triangle with different sizes, and we're asked to visualize these shapes into a company logo. So, I used the circle as the base element to integrate the triangle and square. Using the circle's diameter, I took 6 cm as the base to combine the triangle. Next, I positioned the square between the triangle and the circle. To make it more appealing, I used dashed lines for the square's edges (while pointing at the picture)
RP.06 : How did you create the second logo?
MP.06 : (Pauses briefly) Honestly, I was really confused, ma'am. I didn't know how to make an interesting logo. So, for the second one, I just made it randomly, and I don't think it's appealing..
RP.07 : What do you mean by randomly? Could you explain your process or idea when creating the second logo?
MP.07 : The first time, I focused on creating an interesting company logo. For this one, I just focused on arranging the three flat shapes—circle, square, and triangle. I tried layering them, and it ended up like this, ma'am. But I don't think it's very appealing..
RP.09 : If I gave you more time, could you come up with another logo using a different approach?
MP.09 : Hmm, I'm not sure, ma'am. I'm still struggling to think of another idea.

Based on the interview excerpt, MP was able to explain two different ideas or methods for creating Logo 1 and Logo 2, thus fulfilling the flexibility component. However, MP does not meet the originality indicator, as MP could not present a logo or method different from those already created (Siswono 2018).

From the explanation above, it can be concluded that in solving the geometry problem, MP fulfills only the flexibility indicator of creative thinking. This aligns with previous research stating that campers meet the flexibility indicator of creative thinking but fail to meet the fluency and originality indicators (Suhandoyo and Wijayanti 2016).

Research Subject in the Quitter Category (MQ)

MQ's response to solving the geometry problem can be seen in the following figure.

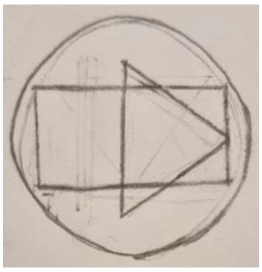

Figure 6. MQ's answer (Logo 1)

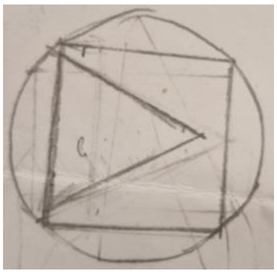

Figure 7. MQ's answer (Logo 2)

Based on MQ's responses, an analysis will be conducted using the three indicators of creative thinking ability: fluency, flexibility, and novelty.

Fluency

MQ, designed two logos. In Figure 7, MQ created a logo consisting of a circle, square, and triangle, with dimensions that adhere to the problem's requirements. However, for the other logo (Figure 6), there was a discrepancy between the steps MQ wrote for constructing the logo (Figure 6) and the resulting logo (Figure 6). In the test sheet, MQ wrote, "Draw a square with side lengths of 8 cm," but the visible drawing is a rectangle. After a follow-up confirmation during the interview, MQ independently realized that what had been drawn did not align with what was intended. This is evident in the following excerpt from the interview:

RQ.05 : *So, how should this image look? (Pointing to Figure 6)*
MQ.05 : *Wait a moment, ma'am. (While looking at the image). Oh, this should actually be a square with equal sides, so this image should resemble Figure 2 (pointing to Figure 7), except the pointed part of the triangle touches the right side of the square. That's what I meant, ma'am.*

Based on the excerpt from the interview, it is evident that MQ created two different logos that comply with the instructions in the problem. Therefore, MQ meets the fluency indicator (Siswono 2018).

Flexibility

In Figure 6, MQ used the circle as the base, as the circle is the largest shape, and then placed a rectangle (MQ misread the problem) and a triangle within the circle, forming Figure 6. To create Figure 7, using the same approach as Figure 6, MQ again used the circle as the base, then placed a square and triangle within the circle, ensuring the sizes adhered to the problem's requirements, forming Figure 7. For Figure 8, MQ repeated the same approach used for the previous logos. This aligns with the following excerpt from the interview with MQ:

RQ.03 : *How did you create the first logo?*
MQ.03 : *Since there are three shapes, ma'am, I started with a circle, estimating its diameter to be 10 cm. Next, I drew a square with sides of 8 cm inside the circle. Lastly, I drew an equilateral triangle with 6 cm sides.*
RQ.04 : *Is this what you mean by a square? (Pointing to Figure 6)*
MQ.04 : *Oh, is it not? Let me check. (Pauses briefly) No, it's not, ma'am. I was focusing on the top and bottom sides being 8 cm, ma'am. (Pointing to the drawing)*
RQ.06 : *How did you create the second logo?*
MQ.06 : *(Pauses briefly) I used the same approach as the first logo, ma'am. I started by drawing the circle, then added a triangle inside it. Lastly, I drew a square where one of its sides aligns with the side of the triangle.*
RQ.08 : *How did you create the third logo?*
MQ.08: *I was in a hurry for this one, ma'am.*
RQ.09 : *If I gave you more time, could you create another logo using a different approach?*
MQ.09 : *(While trying to draw on paper, starting with a circle) I don't know, ma'am. I'm confused.*
RQ.11 : *Why did you start by drawing the circle? Why not start with the triangle or square?*
MQ.11 : *Because the circle is the largest shape, ma'am. So, I thought it should be drawn first.*

Based on the excerpt from the interview, MQ was only able to explain one idea or method to create the two logos, which involved drawing the circle first as the base, using the initial idea that the circle is the largest element and should therefore serve as the foundation. Thus, it can be concluded that in solving the geometry problem, MQ did not meet the creative thinking flexibility indicator (Siswono 2018). This aligns with previous research (Suhandoyo and Wijayanti 2016) which states that Quitter students meet the creative thinking fluency indicator but do not fulfill the flexibility and novelty indicators.

The achievement of each creative thinking indicator across the three subjects is presented in the table below:

Table 2. Achievement of Creative Thinking Indicators by Subject.

No.	AQ Category	Achieved Creative Thinking Indicators
1.	Climber	Fluency dan Flexibility
2.	Camper	Flexibility
3.	Quitter	Fluency

Based on Table 2, the creative thinking level of climber students is at level 3, categorized as creative; camper students are at level 2, categorized as moderately creative; and quitter students are at level 1, categorized as less creative (Siswono 2018). Among the three research subjects, none fulfilled the originality indicator. This indicates that the mathematical creative thinking skills of prospective mathematics teacher students have not been optimally achieved in terms of originality. Additionally, the type of Adversity Quotient (AQ) influences the development of students' mathematical creative thinking skills (Hidayat et al. 2018).

This issue requires serious attention, considering the importance of teacher creativity in educating students to think creatively. Therefore, efforts are needed to enhance the quality of mathematics learning in alignment with current literature to foster a culture of mathematical thinking in schools. This culture should support idea exploration, the creation of creative solutions, and deeper evaluation skills. As stated by Harris (in Mina 2005) and (Rahman 2012), formal mathematics education often emphasizes analytical skills, while creative thinking—which encourages the exploration of ideas and the search for diverse solutions—receives less focus. Strategic steps are necessary to ensure that prospective teacher students not only understand concepts but also develop the ability to cultivate creative thinking in their students.

Conclusion and Suggestion

This study identified the creative thinking abilities of prospective mathematics teacher students based on three indicators: fluency, flexibility, and novelty. The results revealed: 1) Students categorized as climbers fulfilled the fluency and flexibility indicators but did not meet novelty. They were able to produce more than one logo with varied methods but still relied on existing approaches, placing them at the creative level (level 3); 2) Camper students only fulfilled the flexibility indicator, producing logos using two different methods. The fluency and novelty indicators were not met, placing them at the moderately creative level (level 2); 3) Quitter students only fulfilled the fluency indicator, placing them at the less creative level (level 1); 4) Among all the research subjects, none met the novelty indicator, which presents a significant challenge in improving the creative thinking abilities of prospective mathematics teachers.

Higher education institutions should prioritize curriculum development that emphasizes the cultivation of creative thinking skills. Incorporating problem-based geometry with open-ended approaches can serve as an alternative and effective learning method. Additionally, students should actively participate in training and coaching sessions designed to enhance their fluency, flexibility, and originality in solving mathematical problems. Teachers play a crucial role in fostering a culture of creativity by adopting innovative teaching strategies, such as collaborative projects, idea exploration, and solution evaluation. Furthermore, in-depth research is essential to investigate the factors influencing creative thinking abilities, including the impact of Adversity Quotient (AQ), and to assess the effectiveness of interventions aimed at improving these skills.

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