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ANALYSIS OF STUDENTS' MATHEMATICAL CRITICAL THINKING ABILITY BASED ON THEIR ADVERSITY QUOTIENT

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ABSTRACT

Mathematical critical thinking is a fundamental competency required to navigate complex problem-solving in the 21st century. However, empirical observations indicate that students often struggle with analytical reasoning, a deficiency potentially influenced by non-cognitive factors such as Adversity Quotient (AQ). This study aims to analyze the mathematical critical thinking profiles of Grade XII students in Garut Regency, West Java, Indonesia, based on their AQ levels. This research employs a qualitative descriptive design. The subjects were selected via purposive sampling and categorized into three distinct groups based on Stoltz's framework: Quitters, Campers, and Climbers. Ten students were selected from each AQ category.Data were collected through AQ questionnaires, mathematical critical thinking tests, and semi-structured interviews. Data validity was established using time triangulation, followed by data reduction, display, and verification for analysis. The findings reveal a hierarchical consistency between AQ levels and critical thinking ability. Students in the Quitter group were limited to elementary clarification; Campers demonstrated intermediate capabilities but struggled with advanced evaluation; while Climbersmastered all written indicators but faced challenges in verbally articulating their mathematical reasoning.

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INTRODUCTION

The rapid advancement of globalization has made it possible for individuals to access a vast amount of information quickly and easily from different parts of the world. Despite this accessibility, it is unrealistic and unnecessary for individuals to master all available knowledge, considering the enormous volume of information and the fact that not all of it is relevant to

individual needs. The dynamics of global development also require significant changes in competencies, particularly those related to the effective use of information and communication technology in various aspects of life, including education. In this context, society increasingly needs individuals who are competent, adaptable, and capable of competing in a global environment. Therefore, the development of higher-order thinking skills becomes essential, including the ability to think critically, logically, systematically, analytically, and creatively, supported by strong perseverance. As highlighted in previous research (Alfiandra et al., 2022a), critical thinking is one of the key competencies that must be developed to meet these challenges.

The ability to think critically, solve problems, and work collaboratively has become an essential set of competencies for individuals living in the 21st century . These competencies are widely recognized as key skills needed to address increasingly complex challenges(Wulandari et al., 2022) in modern society. In line with this perspective (Rizalno et al., 2022) argue that critical thinking can be categorized as a form of higher-order thinking. It represents a combination of critical and creative thinking processes, characterized by flexibility, ingenuity, and the capacity to identify and utilize available resources effectively in order to achieve optimal outcomes. As a specific form of higher-order thinking, critical thinking has also been widely acknowledged as an important educational goal and is projected to remain a central learning outcome toward 2050 (Charolina, 2025).

Despite the growing emphasis on developing higher-order thinking skills, students' mathematical critical thinking ability remains a major challenge in many countries. International large-scale assessments, such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), consistently report that many students experience difficulties in analyzing mathematical situations, evaluating arguments, drawing logical conclusions, and solving non-routine problems. These findings indicate that a considerable proportion of students still rely on procedural knowledge rather than critical reasoning when solving mathematical tasks.

One strategic effort to address these demands is to enhance the quality of education by emphasizing the development of students' critical thinking skills. Critical thinking can be systematically fostered through classroom instruction, particularly in mathematics education, which inherently encourages reasoning and problem-solving processes (Nadila Almubarokah et al., 2024). The cultivation of these skills equips students to confront challenges more confidently and to solve problems by carefully analyzing their own reasoning before making decisions and drawing conclusions. Through this process, learners are shaped into resilient individuals who are capable of acting based on logical, rational, critical, accurate, efficient, and effective thinking.

Various scholars have proposed different perspectives on the concept of critical thinking. Several notable definitions are described as follows. First, Marvin W. Beyer describes critical thinking as a disciplined form of thinking used to assess the credibility and validity of statements, ideas, arguments, and research findings. Second, Richard Paul and Michael Scriven, as cited in Thomas A. Angelo (Gao et al., n.d.) define critical thinking as a purposeful and reflective intellectual process that involves conceptualizing, applying, analyzing, synthesizing, and evaluating information obtained from observation, experience, reflection, reasoning, or communication to guide beliefs and actions. Furthermore, Joel Rudinow and Vincent E. Barry (Mitarlis et al., 2020) explain that critical thinking emphasizes the use of logical and rational foundations in forming beliefs, supported by a set of standards and procedures for examining, testing, and evaluating ideas or arguments.

Students' critical thinking abilities vary, so indicators are needed to determine students' critical thinking abilities (Irfiani et al., 2023). There are many experts or researchers who have

formulated critical thinking indicators. One of them is according to Ennis (Ennis, n.d.) who groups critical thinking indicators into five groups. The explanation for each of the indicators above is described in the following table.

Table 1. Indicators of Critical Thinking Ability

Critical Thinking Skills	Sub Skills
Provide a simple explanation (Elementary Clarification)	Focusing the statement Analyze the argument Ask and answer classification questions and opposing questions
Building basic skills (Basic Support)	Consider the credibility (criteria) of a source Observe and consider the result of the observation
Making Inferences (Inferring)	Make deductions and consider the results of the deduction
Make further explanations (Advanced Clarification)	Identify terms and consider decisions
Setting strategies and tactics (Strategies and Tactics)	Formulate an actions

One factor that is believed to influence students' critical thinking ability is the Adversity Quotient (AQ) (Widiyasari, 2023) The concept of Adversity Quotient was introduced by Paul Stoltz. Traditional views of intelligence, which mainly emphasize Intelligence Quotient (IQ) and Emotional Quotient (EQ), are often considered insufficient to fully explain an individual's success. For this reason, Stoltz later proposed the concept of Adversity Quotient as another dimension of intelligence that reflects how individuals respond to difficulties.Linguistically, the word *adversity* refers to hardship, difficulty, or misfortune, while *quotient* denotes a level of ability or intelligence. Based on these meanings.

Adversity Quotient can be understood as an individual's capability to confront and manage challenging situations or unfavorable circumstances. According to Stoltz (Wahyuni & Alfina, 2025a), AQ represents a person's capacity to recognize difficulties and transform them through cognitive processes into challenges that can be addressed and resolved. Other scholars have also offered similar perspectives. For instance, Leman describes Adversity Quotient simply as an individual's ability to deal with problems (Rahayu & Alyani, 2020). In this sense, AQ reflects both the psychological and physical capacity that enables a person to cope with obstacles or challenges encountered in life.

According to Stoltz, adversity quotient is an ability consisting of four dimensions which are abbreviated as CO2RE, namely the dimensions of control, origin and ownership, reach and endurance. The description of these four dimensions is explained as follows:

Controls

This dimension is about how much control a person feels over an event that causes difficulties. This dimension is the most important starting point. A person with a higher AQ feels more control over the events they encounter than one with a lower AQ. As a result they will take

actions that result in even more control. A person with a higher AQ is more likely to climb and is relatively immune to helplessness. It was as if they were protected by an impenetrable force field and they did not fall into bottomless despair. Meanwhile, those with low AQ tend to camp or stop.

Origin and ownership

The dimension is about who or what is the origin of difficulties and the extent to which a person recognizes the consequences of these difficulties. A person who has a low AQ tends to place undue guilt on bad events that occur, seeing himself as the cause of the origin of these difficulties. Meanwhile, someone who has a high AQ will avoid bad events, always blame others and will not learn anything.

Reach

The dimension is about the extent to which difficulties will reach other parts of the individual's life. Responses with low AQ will make it difficult to enter other aspects of a person's life. The lower the reach, the greater the likelihood of treating bad events as a plan by allowing them to spread, sucking away the individual's happiness and peace of mind in the process. Conversely, the higher the reach, the greater the possibility that someone will limit the scope of the problem to the event at hand.

Endurance

The dimension is about how long the difficulty will last and how long the cause of the difficulty will last. The lower the endurance, the more likely a person is to assume that difficulties and their causes will last a long time. Someone who sees their abilities as a cause (stable cause) tends to be less likely to persist than people who attribute failure to the efforts (temporary causes) they make such as: this always happens, things will never get better, I'm not good at adapting need, usually this is how it goes, my life is ruined, my life is very bad.

These dimensions will be used by researchers as a guide in measuring students' adversity quotient levels and their relationship to students' ability to solve mathematical literacy problems (Dan & Amanah, 2014). Stoltz groups individuals based on their fighting power into three, namely climbers, campers and quitters. The use of this term is taken from the story of Everest climbers. There are climbers who give up before climbing, feel satisfied at reaching a certain height, and continue climbing to the highest peak. Then Stoltz stated that people who give up are called quitters, people who feel satisfied with certain achievements are called campers, and people who want to continue achieving success are called climbers (Alfian et al., n.d.).These levels are described as follows:

Quitter

Quitters refer to individuals who tend to give up when encountering challenges. They often avoid responsibilities, withdraw from difficult situations, and decide to discontinue their efforts. Rather than persisting in the face of obstacles, individuals in this category choose to stop trying and ignore the inner motivation that encourages people to continue striving. As a result, they frequently miss various opportunities and experiences that life could otherwise provide.

Camper

Camper refer to individuals who make some effort in facing challenges but tend to feel quickly satisfied with the achievements they have obtained. After reaching a certain point, they often stop striving for further progress and prefer to remain in a comfortable position. Individuals in this category may lose motivation to continue improving themselves and instead choose to stay in situations that feel safe and familiar. Consequently, many campers perceive their current

condition as sufficiently successful, which reduces their desire to pursue further development or make additional efforts.

Climber

Climber are individuals who consistently strive to overcome challenges throughout their lives. Regardless of their background, strengths or limitations, as well as favorable or unfavorable circumstances, they remain persistent in pursuing their goals. Individuals with this type of Adversity Quotient tend to maintain their effort and determination despite the obstacles they encounter.

There is a strong theoretical relationship between AQ and critical thingking ability. Students with high AQ (Climbers) are predicted to be able to persist through the demanding process of critical thinking (such as evaluating arguments and seeking alternative solutions), whereas students with low AQ (Quitters) tend to stop at the early stage of problem interpretation.

Although the urgency of these two variables has been acknowledged, there is a research gap in the existing literature. Most previous studies have focused more on the relationship between AQ and general problem-solving ability (Apriliana & Malasari, n.d.) or academic achievement, while only a limited number specifically examine the indicators of mathematical critical thinking (interpretation, analysis, evaluation, and inference).

The majority of prior research subjects have been junior high school students or university students. Studies highlighting Grade XII senior high school students remain scarce. In fact, Grade XII students are in a crucial transitional phase toward higher education or the workforce, where academic pressure is very high and both critical thinking maturity and resilience (AQ) are rigorously tested. Many studies are merely correlational in nature (seeking numerical relationships) and have not conducted in-depth qualitative analyses of the profiles or patterns of students' critical thinking errors at each AQ level (Quitter, Camper, Climber).

Based on these gaps, this study becomes important to map how students' Adversity Quotient levels influence the quality of their critical thinking. This information is crucial for educators in designing appropriate intervention strategies—not only to sharpen cognition but also to strengthen students' mental resilience. Therefore, this study aims to analyze the mathematical critical thinking ability of Grade XII students in relation to their Adversity Quotient.

METHOD

This research employed a qualitative descriptive design involving three twelfth-grade students from a senior high school in Garut Regency, West Java, Indonesia. The participants were selected using purposive sampling to obtain in-depth information regarding students' mathematical critical thinking abilities based on their Adversity Quotient (AQ). The selection of only three students was based on the qualitative nature of the study, which emphasized an in-depth exploration of students' thinking processes rather than the generalization of findings to a larger population. Therefore, a small number of participants was considered appropriate to allow the researchers to examine students' responses and reasoning processes comprehensively through written test results and follow-up interviews.

The three students were selected to represent the three AQ categories, namely climber, camper, and quitter. The selection criteria were determined based on the students' AQ questionnaire scores and their ability to provide information relevant to the research objectives. Specifically, one student with the highest AQ score was selected to represent the climber category, one student with a moderate AQ score was selected to represent the camper category, and one student with the lowest AQ score was selected to represent the quitter category. In addition to their AQ classification, the selected students met the following criteria: (1) they had completed

the AQ questionnaire and the mathematical critical thinking test; (2) they were able to communicate their mathematical reasoning during the interview; (3) they were willing to participate in the interview; and (4) they represented distinct AQ categories required for the comparison of mathematical critical thinking abilities.

The selection of these three participants was intended to provide a representation of different responses to mathematical difficulties. Students categorized as climbers were expected to demonstrate persistence and a tendency to continue working when encountering challenging problems. Students categorized as campers were expected to demonstrate moderate persistence, while quitter students were expected to show a greater tendency to give up or discontinue their problem-solving efforts when facing difficulties. Thus, the three participants provided meaningful cases for analyzing differences in mathematical critical thinking abilities across AQ categories.

The data were obtained through a mathematical critical thinking test and follow-up interviews. Both sources of data were examined to portray students' levels of mathematical critical thinking according to five indicators: (1) giving simple explanations (elementary clarification), (2) developing basic supporting skills (basic support), (3) drawing conclusions (inferring), (4) presenting more advanced explanations (advanced clarification), and (5) determining appropriate strategies and tactics (strategies and tactics).

The data collection procedures combined written and oral communication techniques. The written technique involved an essay-type test consisting of four items designed to measure mathematical critical thinking, whereas the oral communication technique was conducted through unstructured interviews. Prior to implementation, the research instruments were reviewed and validated by a university lecturer and a mathematics teacher from the participating school. The validation results confirmed that the instruments were suitable for use in this study.

RESULTS AND DISCUSSION

Results

Three students were purposively selected as research participants, each representing different levels of Adversity Quotient (AQ): one student categorized as having a low AQ level (*Quitter*), one with a moderate AQ level (*Camper*), and one with a high AQ level (*Climber*). A written test was administered to assess students' critical thinking skills in solving mathematical problems.

The findings of this study were derived from the results of the critical thinking skills test. To evaluate students' ability to solve mathematical problems critically, the researcher designed a test consisting of four essay questions. Following the administration of the test, interviews were conducted to obtain deeper insights into how students applied critical thinking when solving mathematical problems. The interviews aimed to further explore the reasoning processes underlying students' responses to the test items. The list of interview participants is presented in Table 2.

Table 2. Student AQ Category

Student Code	Category of AQ
S1	Quitter
S2	Camper
S3	Climber

Based on table 2 above, information is obtained that S1 students are only able to solve questions with the Elementary Clarification indicator, Masters students are able to solve questions with the Elementary Clarification and Inferring indicators, while S3 students are able to solve all the indicators on the questions given, namely the Elementary Clarification indicator. , Basic Support, Inferring, Advanced Clarification, and Strategies and Tactics. The results of the Adversity Quotient (AQ) test provide the following results.

Based on this table. of all the class interviews were conducted to strengthen students' answer and determine students' critical thinking abilities in solving given mathematical problems. Information was obtained, namely: 1) there were students who were only able to solve questions with Elementary Clarification indicators and were confused about solving questions that contained other indicators; 2) there are students who can only solve questions containing Elementary Clarification and Inferring indicators; 3) there are students who are able to solve problems that contain all indicators of critical thinking abilities but when interviewed, the students cannot explain the method used to solve the problem; 4) most students are confident in their answers.

Table 3. List of Interview Participant

Student Code	Indicator				
	Elementary Clarification	Basic Support	Inferring	Advanced Clarification	Strategies and Tactics
S1	√	-	-	-	-
S2	√	-	√	-	-
S3	√	√	√	√	√

Question Number 1

A class consists of 40 students consisting of 20 female students and 20 male students. If the average math score for female students is 80 and the average math score for male students is 85, what is the average math score for all students?

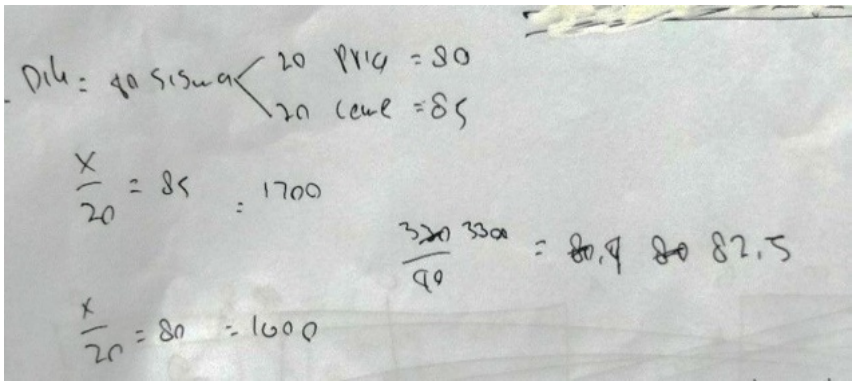

Figure 1. Students' answer to question number 1.

This item required subjects to synthesize gender-specific averages to determine the total class mean.Figure 1. Students' answer to question number 1

- S1 Analysis: Demonstrated a failure in problem processing. The subject merely restated the given data without attempting any mathematical operations.
- S2 Analysis: Successfully identified the problem's goal (Elementary Clarification) but failed to reach the correct solution due to a lack of precision in the final calculation phase.
- S3 Analysis: Showed complete mastery by identifying the objective and executing a flawless calculation.Within the broader participant pool (the entire class), there was an 80% achievement rate for the "Elementary Clarification" indicator on this question, indicating that most students could identify the "known" and "asked" components of the prompt.

Question Number 2

Given a rectangle ABCD with length AB=8 cm and BC=6cm. Then a quadrilateral ABQP will be created with point P located on CD and point Q located on BC with CP=CQ, then you have to place points Q and P so that you get the largest ABQP. Can this problem be solved with the simplest mathematical model? Then determine the CP Length.

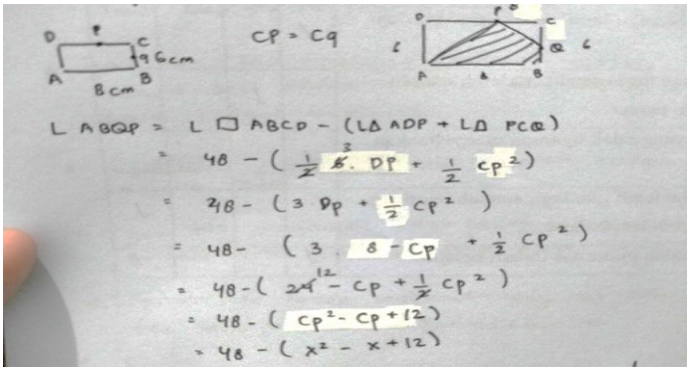

Figure 2. Students' answer to question number 2

This problem challenged subjects to construct a mathematical model for a quadrilateral within a rectangle to determine the CP length that maximizes area.Figure 2. Students' answer to question number 2

- S1 Analysis: While the subject could list the basic geometric parameters provided, they were unable to formulate a strategy or define the question's specific objective.
- S2 Analysis: Identified the objective and utilized the data, but the final response was invalid due to computational inaccuracies within the geometric model.
- S3 Analysis: Successfully constructed a valid answer and demonstrated a clear understanding of the optimization objective.

Question Number 3

There is a square swimming pool with sides 20 meters long. Around the swimming pool there is a path that is 1 meter wide. If the price for building a swimming pool is IDR 500,000 per square meter and the price for building a footpath is IDR 100,000 per square meter, how much will it cost to build the swimming pool and footpath?

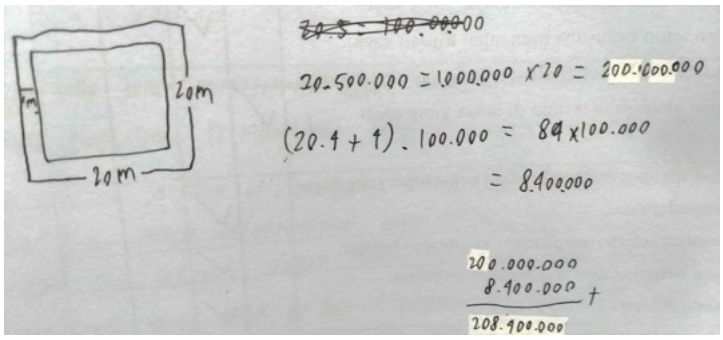

Figure 3. Students' answer to question number 3.

This item assessed the subjects' ability to calculate total costs for a pool and surrounding path based on area-specific pricing. Analysis of Question 3 performance indicates a clear stratification of skills: S1 remained limited to identifying basic pool dimensions (Elementary Clarification), while S2 and S3 demonstrated the ability to draw logical conclusions (Inferring) regarding total area and cost distribution. S3 alone maintained the strategic rigor necessary to ensure the calculation accounted for both distinct construction zones.

Question Number 4

Tika wants to go on holiday to various places. It provides money for transportation and consumption costs. Costs for destinations, vehicles and hotels are categorized as transportation costs, while food and souvenir costs are categorized as consumption costs. Tika estimates that the money she has will not be less with the following distribution: 1) Consumption costs of at least IDR 1,500,000; 2) Transportation costs cannot be more than consumption costs; 3) The total money Aan has is IDR 5,000,000

a. *If Tika has determined that the total transportation and consumption costs are x and y respectively, then write the problem above in the form of a mathematical sentence!*
b. *If Tika wants to spend as little as possible, Tika decides that she will use transportation costs equal to consumption costs. Is the decision taken by Tika correct? Explain your answer!*
c. *If in the middle of the trip, Tika has already incurred transportation costs of IDR. 1,600,000, is Tika's decision still the best, namely dividing transportation costs and consumption costs by the same amount? Explain your answer with mathematical procedurs or steps!*

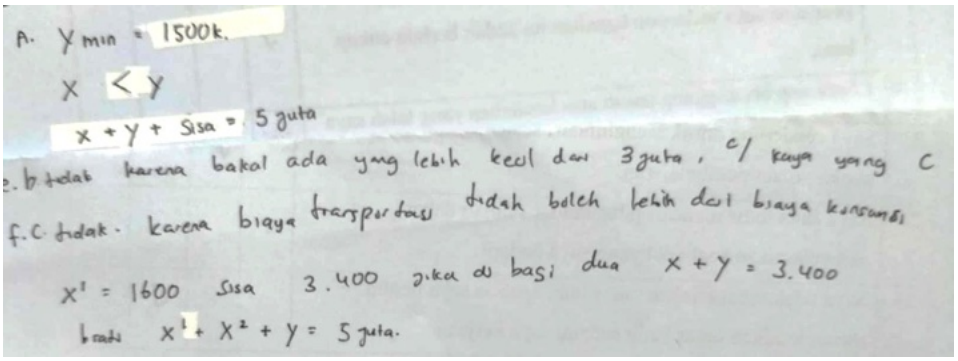

Figure 4. Students' answer to question number 4.

This question required the translation of dietary and transportation budget constraints into mathematical sentences and an evaluation of budgetary logic.Figure 4. Students' answer to question number 4

- S3 Analysis: S3 was the only participant to solve this problem correctly, employing a robust logical structure. During the interview, S3 initially hesitated but eventually displayed high communicative competence, providing a clear mathematical defense for their decision-making logic.
- Comparative Observations: While lower AQ subjects relied on rote memorization or algorithmic guesses that failed in this non-routine context, S3's performance highlighted the capacity to justify the "why" behind the mathematical "how."

Discussions

The variations in depth observed across S1, S2, and S3 suggest that a student's AQ level serves as a mediator for cognitive persistence during complex modeling. Evaluating these results against the framework of Chaname-Chira et al. (2024), we find that "quality" in mathematical problem solving is not merely about correctness, but about the ability to sustain critical inquiry through multiple levels of abstraction. S3 (the Climber) met high-quality benchmarks by consistently applying diverse indicators, whereas the Quitter and Camper profiles showed significant attrition in analytical quality as problem complexity increased.

The "Elementary Clarification" finding suggests a widespread ability to identify "known" and "asked" elements, yet a systemic failure in execution. This was most pronounced in Subject S2, who demonstrated conceptual comprehension but failed through procedural inaccuracy. This discrepancy aligns with Hidayat & Sariningsih (2018), who posit that students often grasp the problem's context yet lack the precision required for successful resolution, a trait often exacerbated by the Moderate AQ tendency to settle for "good enough" rather than exactitude.

Findings from the geometric modeling in Question 2 highlight the "Basic Support" indicator (Alfiandra et al., 2022b). Errors observed can be classified using Karim's (2015) taxonomy:

- Comprehension Deficit: Observed in S1, whose failure to articulate a goal despite listing information suggests a breakdown in translating linguistic inputs into mathematical objectives.
- Procedural/Computational Inaccuracy: Observed in S2, who understood the requirements of the geometric model but failed to maintain precision during operations. While the raw data in some source contexts incorrectly attributes this to "averages," it is more accurately defined as a failure in geometric calculation precision.

Subject S3's performance exemplifies the "Strategies and Tactics" indicator (Syamsuddin, 2025). S3 exhibited Creative Mathematically Founded Reasoning (CMR), which is characterized by the construction of novel reasoning chains justified by mathematical properties. This stands in stark contrast to "lithogenic" or rote reasoning, where students apply memorized formulas without understanding their foundational logic. Although some initial interview observations suggested S3 struggled to verbalize methods, the ultimate depth of their CMR—evidenced by their ability to provide robust mathematical arguments for Question 4—distinguishes high-level critical thinking from the mechanical application of learned algorithms.

CONCLUSION

This study concludes that students' mathematical critical thinking abilities are intrinsically linked to their Adversity Quotient (AQ) levels. Overall, the critical thinking proficiency of Grade XII students in the observed West Java high school remains suboptimal and exhibits a

hierarchical pattern consistent with Stoltz's theory. Specifically, students in the Quitter category demonstrated the lowest proficiency, limited solely to the 'Elementary Clarification' indicator; they were able to identify information but struggled to process it further. Camper students showed moderate capabilities, successfully navigating 'Elementary Clarification' and 'Inference', yet failing to reach advanced evaluation stages.

A notable discrepancy was observed in the Climber category. While these students successfully fulfilled all written critical thinking indicators, the interview data revealed a gap in their mathematical communication skills. Although they could arrive at correct solutions, they exhibited difficulties in verbally articulating their reasoning and justification. This suggests that while high-AQ students possess strong procedural resilience, they may still require support in developing metacognitive awareness and communicative adaptability . Therefore, future mathematics instruction should not only focus on resilience but also on fostering the ability to communicate mathematical arguments verbally

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