



Beyond Intelligence: Does Adversity Quotient Predict Success in Higher-order Mathematics?

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Abstract

While mathematical proficiency is often attributed to cognitive intelligence, success in mastering Higher-Order Thinking Skills (HOTS) frequently hinges on student resilience. This study investigates the premise of "beyond intelligence" by evaluating whether the Adversity Quotient (AQ)—categorized into Climbers, Campers and Quitters—serves as a reliable predictor for solving complex mathematical challenges. Employing a qualitative descriptive design, the research examined eighth-grade students at a public junior high school in Makassar, Indonesia. Data was gathered through the Adversity Response Profile, two open-ended HOTS tasks on systems of linear equations and semi-structured clinical interviews. The findings confirm that AQ significantly indicates mathematical persistence, directly correlating with formal test performance. Performance divergences across AQ categories emerge sharply at the solution-planning stage. Although all students possessed equivalent basic problem-understanding, only high-AQ students successfully transformed information into mathematical models under cognitive pressure. Climber subjects demonstrated mature self-regulation via independent backtracking and verification. Camper subjects exhibited conditional resilience, with accuracy declining as procedural complexity increased. Meanwhile, Quitter subjects displayed profound psychological barriers and cognitive anxiety, resigning at the linguistic literacy stage. Consequently, these results suggest that mastering higher-order mathematics requires modern educational frameworks to shift from purely cognitive metrics toward actively fostering crucial non-cognitive components like the adversity quotient to ensure sustainable, long-term academic success for all learners.

Keywords: Adversity Quotient, Beyond Intelligence, Higher-order Thinking Skills, Mathematics Problem Solving, Polya Stages.

Introduction

Mathematics education at the public middle school level represents the most crucial and yet vulnerable cognitive transition phase in students' academic development (1-3). During this period, students experience not only a changing school environment but also a fundamental shift in thinking demands from the concrete to the abstract (2, 4). Success or failure in navigating this transition will lay the foundation for how students view their future academic abilities, particularly in the fields of science and technology.

Specifically, at this stage, students experience a drastic shift from procedural mathematics, which focuses on basic arithmetic operations and formula memorization, to higher-order Mathematics (5). New learning materials, such as abstract algebra and Euclidean geometry, which require logical proof and complex data analysis, force students to move beyond memorization. Instead,

they are required to operate at a much higher cognitive level, encompassing analytical, evaluation and solution-creation skills.

However, empirical reality in the field often reveals a wide gap. Many students who previously achieved excellent performance and experienced no significant difficulties in elementary school suddenly experience a significant decline in learning achievement upon entering junior high school (6, 7). This decline is not simply a technical instructional issue or a lack of practice. It is a direct result of cognitive shock when students encounter the characteristics of high-level mathematics, filled with extreme abstraction and algorithmic intricacies. This situation often triggers profound confusion and frustration for students who are unprepared for it.

The root of this phenomenon lies in the assumptions prevalent in our education system,

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which often assume that mastery of academic material is a linear function of a student's material is a linear function of a student's intelligence quotient (IQ) (8). Over the past decade, the debate regarding the determinants or predictors of academic success has been dominated by IQ scores (9, 10). However, in the context of higher-level mathematics learning, the IQ variable often fails to explain why students with high intellectual intelligence give up easily when faced with non-routine problems that do not have instant solutions (11-13).

The weakness of this IQ-based view arises because the process of finding proof or solutions in advanced mathematics requires extensive mental resilience. This process involves trial and error, intellectual impasses and repeated failures before the correct answer can be formulated (14-17). Based on these limitations, the concept of "Beyond Intelligence" in this article is presented to challenge the long-held dogma that places innate intelligence as the sole determinant of success. Especially in public junior high schools—where diverse socioeconomic backgrounds often create additional psychological stress—the presence of moderating variables capable of explaining students' mental resilience is crucial to actualizing their latent intellectual potential into tangible achievements.

To address this empirical gap, Adversity Quotient (AQ) is recontextualized as an operationalized proxy for mathematical resilience rather than an isolated psychological trait, following frameworks established in previous studies (18-20). In mathematical problem-solving, complex non-routine tasks represent a form of productive struggle, where cognitive obstacles require students to mobilize affective and metacognitive resources (21-23). Rather than operating independently, AQ reflects the dynamic interplay between a student's self-efficacy, mathematics anxiety and self-regulated learning (SRL) capabilities. High-AQ individuals leverage strong self-efficacy to regulate anxiety and sustain persistence during cognitive dead-ends, whereas low-AQ individuals experience heightened affective barriers that disrupt strategic thinking. Stoltz's typology (Quitters, Campers and Climbers) provides a nuanced lens to observe how these psychological constructs manifest during mathematical problem-solving. Quitters represent

students overwhelmed by mathematics anxiety and low academic self-efficacy;

when encountering cognitive friction, their premature cognitive surrender stops the productive struggle before strategic execution begins (24). Campers exhibit conditional persistence; while possessing sufficient baseline self-efficacy, their self-regulated learning mechanisms decline linearly as procedural complexity increases, leading them to settle in a cognitive comfort zone (25). Conversely, Climbers embody high mathematical resilience. They view intellectual hurdles as opportunities for productive struggle, deploying mature metacognitive monitoring—such as explicit error evaluation and adaptive backtracking—to sustain task persistence despite cognitive pressure (26, 27).

Within this framework, AQ is operationalized through the CO2RE dimension (Control, Ownership, Reach and Endurance) to map students' cognitive and affective self-regulation (28, 29). Within public junior high school ecosystems, the Endurance and Control dimensions directly modulate mathematics anxiety and persistence (30). Students who perceive mathematical difficulties as transient (high endurance) and controllable are more likely to activate metacognitive control, transforming anxiety into constructive problem-solving behavior. By integrating these four dimensions, this study uncovers how internal ownership and emotional reach shape students' self-efficacy, determining whether cognitive struggle yields learning gains or academic paralysis.

The distinct novelty of this study lies in examining public junior high school students (ages 12–15)—a transitional developmental stage where mathematical self-concept, anxiety patterns and metacognitive habits crystallize. Departing from traditional research reliant on teacher-assigned grades (31, 32), this study utilizes a validated Higher-Order Thinking Skills (HOTS) instrument designed to provoke authentic productive struggle in non-routine mathematics. By deconstructing the psychographic profiles of Climbers, Campers and Quitters through the synergistic lenses of mathematical resilience, SRL, metacognition and affective control, this study offers a new paradigm for educational policy: enhancing national numeracy requires going beyond curriculum delivery to systematically cultivate students'

metacognitive resilience and self-regulated persistence under cognitive pressure.

Methodology

This study employs a qualitative descriptive design through a cognitive phenomenology approach to investigate the extent to which Adversity Quotient (AQ) serves as a predictor of student success in solving higher-order thinking skills (HOTS) problems (33). This study seeks to go beyond the standard cognitive ability (IQ) paradigm by focusing analysis on aspects of intellectual resilience, the use of heuristic strategies and the depth of students' metacognitive reflection when facing non-routine obstacles at each stage of Polya's problem-solving. Through this lens, researchers can capture the essence of students' cognitive experiences when they encounter an "intellectual impasse" and how their psychological capacities determine their successful solution navigation.

This study was conducted at State Junior High School 18 Makassar, Indonesia, utilizing a two-stage criterion-referenced sampling framework drawn from an overall target population of eighth-grade students ($N=210$). In Stage 1, an initial cohort of 30 eighth-grade students ($M_{\text{age}}=13.6$ years, $SD=0.5$, age range: 13.1–14.2 years; 16 females, 14 males) underwent psychometric screening using Stoltz's Adversity Response Profile (ARP) to map Adversity Quotient (AQ) typologies into Climbers, Campers and Quitters. All screened students shared a standardized academic background, having completed the centralized state mathematics curriculum with a baseline end-of-semester achievement mean of 78.4 ($SD=6.8$, scale 0–100). In Stage 2, a targeted sample of three focal subjects ($n=3$; 2 females, 1 male; mean age = 13.5 years) representing each distinct AQ profile was selected for detailed clinical interviewing based on strict inclusion criteria:

- a) confirmed psychometric typology placement (one Climber, one Camper, one Quitter),
- b) moderate-to-high prior mathematics achievement (score ≥ 75) to ensure baseline domain knowledge for higher-order thinking tasks,
- c) high verbal communicativeness evaluated via observational rubrics and
- d) verified informed parental consent; while exclusion criteria comprised chronic

absenteeism ($>15\%$), severe communication anxiety and unverified academic records.

The predictive power of the Adversity Quotient (AQ) on students' mathematics performance was measured through a synergy of three primary instruments validated by experts in mathematics education and educational psychology (34). The first instrument was the Adversity Response Profile (ARP) questionnaire, adapted to examine the Control, Ownership, Reach and Endurance ("CO" & "RE") dimensions in students. As the primary supporting instrument, a Higher-Order Thinking Skills (HOTS)-based mathematics test on Systems of Linear Equations in Two Variables (SPLDV) was developed (35). The theoretical foundation for classifying these tasks as HOTS is grounded in Bloom's Revised Taxonomy—specifically targeting the higher-order cognitive dimensions of Analyzing (C4), Evaluating (C5) and Creating (C6)—as well as Polya's mathematical problem-solving framework. The tasks require non-routine cognitive processes, including deconstructing complex contextual word problems, formulating algebraic models, verifying constraint consistency and evaluating multi-step solution pathways. To rigorously assess students' affective and intellectual resilience under cognitive pressure, these tasks were specifically engineered to create a "cognitive dead-end" condition—a deliberate bottleneck forcing students into productive struggle when initial standard procedures fail (36). To evaluate student performance, a validated 4-point analytic scoring rubric adapted from Holistic Problem-Solving Rubrics was utilized (37), assessing four distinct performance criteria:

- (i) Problem Comprehension and Translation,
 - (ii) Strategy Selection and Planning,
 - (iii) Mathematical Execution and Accuracy and
 - (iv) Metacognitive Verification and Backtracking.
- Prior to field administration, all HOTS tasks and scoring rubrics underwent content and construct validation by a panel of three experts in mathematics education, achieving a Content Validity Index (CVI) exceeding 0.85 (38).

Finally, semi-structured clinical interviews were conducted to externalize students' underlying cognitive processes, strategy choices and affective motives for either persisting or discontinuing problem-solving efforts.

Data analysis was conducted in an interactive, iterative cycle based on the Miles model, encompassing data reduction, data display and conclusion drawing/verification. To systematically reduce and structure the empirical evidence, an explicit a priori coding scheme was applied to students' written solutions. This scheme evaluated three primary dimensions across Polya's problem-solving stages and HOTS cognitive indicators:

- (a) algebraic representation (formalization of variables and constraint formulation),
- (b) heuristic choices (algorithm execution, substitution/elimination pathways and alternative strategy generation under cognitive dead-ends) and
- (c) error typologies (conceptual, procedural, or transformation errors).

Concurrently, clinical interview audio recordings underwent verbatim transcription and were segmented into discrete meaning units. Applying a two-cycle thematic coding protocol (39), First-Cycle initial coding identified explicit cognitive/affective actions, which were subsequently synthesized through Second-Cycle Pattern Coding to map students' metacognitive reflections, decision-making motives and persistence barriers directly against Stoltz's Control, Ownership, Reach and Endurance (["CO"]_2 "RE") dimensions.

Data display was operationalized through joint comparative matrices structured around Polya's four problem-solving stages. These joint displays

systematically cross-tabulated three synchronized analytical streams:

- (i) student written work reflecting cognitive performance,
- (ii) time-stamped interview excerpts capturing internal thought processes and metacognitive shifts and
- (iii) psychometric ARP profiles characterizing psychological reactions.

Methodological trustworthiness and credibility were established through rigorous data triangulation (40). By synthesizing written artifacts, time-stamped verbalizations and psychometric profiles within joint comparative matrices, the analytical framework enabled direct comparative analysis across Climber, Camper and Quitter typologies navigating non-routine Systems of Linear Equations in Two Variables (SPLDV). This holistic triangulation ensured that inferences regarding the predictive role of AQ and the internal dynamics of mathematical resilience were methodologically sound, objective and fully grounded in empirical data.

As shown in Figure 1, this study deployed a multi-stage cognitive phenomenology framework to systematically examine how student resilience modulates problem-solving performance. The architecture details the continuous integration of psychometric screening, HOTS-based task performance, clinical interviews and interactive data triangulation following the Miles and Huberman model.

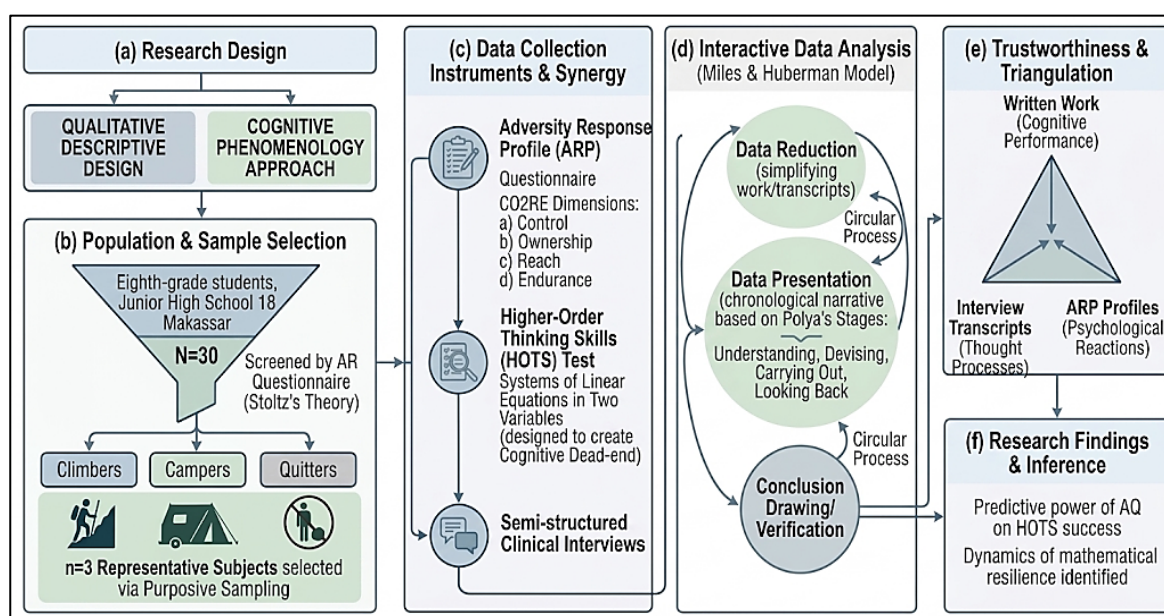


Figure 1: Methodological Framework of the Cognitive Phenomenology Study

Results

Overview of Research Data

This study integrates quantitative data from the Adversity Response Profile (ARP) with qualitative data from the Higher-Order Thinking Skills (HOTS) test and clinical interviews to evaluate how Adversity Quotient (AQ) predicts mathematical success. Rather than viewing AQ as an isolated psychological construct, this study situates AQ as an empirical operationalization of mathematical resilience, examining how it interacts dynamically with self-efficacy, mathematics anxiety, self-

regulated learning (SRL) and metacognitive monitoring during productive struggle.

Initial measurements of 30 eighth-grade students using the ARP instrument revealed varying levels of resilience, categorized into three Stoltz typologies: Climber, Camper and Quitter. Using purposive sampling, three representative subjects were selected for in-depth clinical analysis to capture how differences in affective control and metacognitive habits dictate problem-solving trajectories. Subject identification data and initial performance profiles are summarized in Table 1.

Table 1: Research Subjects Based on Adversity Quotient (AQ)

Initial	ARP	Code	AQ	Integrated Psychological and Resilience Characteristics in HOTS
	Score		Category	
RZR	175	SCL	Climber	High Mathematical Resilience and High Self-Efficacy: Demonstrates active metacognitive monitoring and sustained persistence; transforms mathematics anxiety into productive struggle.
FRS	140	SCA	Camper	Conditional Resilience and Moderate SRL: Exhibits functional self-efficacy in routine tasks; however, metacognitive effort declines linearly when procedural complexity escalates.
AB	95	SQU	Quitter	High Mathematics Anxiety and Low Self-Efficacy: Manifests premature cognitive surrender during initial task interpretation; lacks self-regulated strategies to initiate productive struggle.

Table 1 shows that the distinct Anxiety-Regulation Profile (ARP) configurations establish a critical theoretical and empirical framework for elucidating how non-cognitive mechanisms modulate cognitive performance. While SCL subjects exert strategic cognitive control through well-developed self-regulatory mechanisms, SQU subjects exhibit emotional paralysis prior to activating their intellectual capacity. These findings demonstrate that proficiency in higher-order mathematical problem-solving necessitates robust metacognitive stability and affective regulation, transcending reliance on raw cognitive ability alone.

Students' Performance on HOTS Mathematics Test

Selected subjects completed a validated HOTS mathematics test consisting of open-ended problems on Systems of Linear Equations in Two Variables (SPLDV). The instrument was designed to elicit authentic productive struggle across the four stages of Polya's problem-solving framework: understanding the problem, devising a plan, carrying out the plan and looking back. Table 2 summarizes the score distribution across subjects. The findings confirm a linear relationship between AQ typologies, psychological resilience and HOTS performance.

Table 2: Comparative HOTS Test Scores Across AQ Typologies

Code	Q1a	Q1b	Q1c	Q1d	Q2	Total Score	Final Score
SCL	3	2	3	2	10	20	100
SCA	3	1	1	0	3	10	50
SQU	3	0	0	0	3	6	30

Note: SCL = Climber, SCA = Camper, SQU = Quitter.

As shown in Table 2, superior performance in Higher-Order Thinking Skills (HOTS) is not solely determined by conceptual knowledge mastery but is heavily modulated by task persistence and affective regulation. Specifically, SCL demonstra-

ted optimal performance by maintaining robust metacognitive control under increased task complexity; conversely, SCA and SQU exhibited cognitive overload as processing demands intensified.

Clinical Interview and Micro-process Analysis

To unravel the dynamic interplay among mathematics anxiety, metacognition and self-efficacy, clinical interviews were analyzed across Polya's four stages.

Subject Climber (SCL)

Researcher: "After reading Question 1, what important information did you identify?"

SCL: "There are two system conditions. First, 3 books and 2 pencils cost Rp15,000. Second, 4 books and 1 pencil cost Rp17,000. I defined variables x as the price of one book and y as the price of one pencil."

Researcher: "How do you plan to solve for these variables?"

SCL: "I will set up a system of linear equations, then apply elimination to remove y first because its coefficient is easier to match. After finding x , I will substitute it back to get y . I chose this because it minimizes operational error."

SCL exhibits high self-efficacy and mature self-regulated learning (SRL). Rather than reacting with anxiety, SCL approaches task complexity as a productive struggle, using metacognitive planning to select an optimal algebraic strategy.

Camper Subject (SCA)

Researcher: "Can you explain what you understand from this problem?"

SCA: "Um... 3 books and 2 pencils cost Rp15,000 and 4 books and 1 pencil cost Rp17,000. We need to find the cost of buying more items."

Researcher: "What steps will you take to solve it?"

SCA: "I'll try using the elimination method we learned in class. I will plug in the numbers and subtract them, hopefully getting the right answer." SCA demonstrates conditional resilience. While possessing baseline self-efficacy for standard procedural steps, SCA lacks deep metacognitive monitoring. When calculations become multi-layered, SCA's persistence declines, leading to cognitive fatigue.

Subject Quitter (SQU)

Researcher: "What information did you gather after reading the question?"

SQU: (Pauses, looking visibly anxious) "There are books and pencils with prices... but I am confused by all these numbers. Should I just add them together?"

Researcher: "Look closely at the question stem; what is it asking you to find?"

SQU: "To find the price... but I don't know where to start. This problem looks different from the routine exercises. The wording makes me feel lost, so I don't think I can solve it."

SQU experiences high mathematics anxiety and low self-efficacy. Cognitive anxiety consumes working memory capacity, triggering premature cognitive surrender during the initial literacy phase and preventing any engagement in productive struggle.

Analysis of Problem-solving Processes Based on Polya's Stages

Tables 3 and 4 delineate the comparative cognitive dynamics observed across Polya's problem-solving stages for Items 1 and 2, respectively.

Table 3: Comparative Problem-solving Dynamics Across Polya's Stages (Question 1)

Polya's Stage	Climber (SCL)	Camper (SCA)	Quitter (SQU)
Understanding the Problem	Accurately extracts relationships; high self-efficacy; low affective interference.	Accurately restates facts; moderate self-efficacy; relies on literal text repetition.	Accurately restates facts; high mathematics anxiety; questions capability.
Planning the Solution	Constructs accurate algebraic model ($3x+2y=15000$); deploys metacognitive strategy selection.	Constructs partial model; limited SRL leads to minor structural errors under complexity.	Fails to construct mathematical model; cognitive anxiety impedes structural abstraction.
Implementing the Plan	Executes elimination-substitution systematically; demonstrates active backtracking upon error.	Applies procedural steps with errors; abandons effort when calculations become complex.	Makes no attempt; exhibits complete loss of task persistence.
Reviewing the Results	Performs rigorous back-substitution to verify correctness; high metacognitive regulation.	Conduct cursory check without mathematical verification.	Omits review; experiences learned helplessness.

As shown in Table 3, comparative analysis across Polya's stages reveals distinct cognitive, metacognitive and affective trajectories modulated by

students' Adversity Quotient (AQ). Climbers (SCL) exhibit high mathematical resilience and metacognitive control, accurately modeling

relational structures ($3x+2y=15000$), executing elimination-substitution with active error backtracking and verifying solutions rigorously. Conversely, Campers (SCA) display a surface-level approach bounded by moderate self-efficacy; while able to restate facts, they form incomplete representations, show procedural inconsistency under complexity and conduct superficial verification. Meanwhile, Quitters (SQU) suffer from

severe mathematics anxiety and learned helplessness, which paralyzes structural abstraction and causes complete failure in model construction, execution and verification. Overall, higher AQ directly corresponds to superior strategic flexibility, heightened metacognitive monitoring and sustained task persistence during non-routine problem solving.

Table 4: Comparative Problem-solving Dynamics Across Polya's Stages (Question 2)

Polya's Stage	Climber (SCL)	Camper (SCA)	Quitter (SQU)
Understanding the Problem	Accurately identifies structural variables and constraints.	Accurately identifies known values.	Identifies surface numbers; expresses emotional apprehension.
Planning the Solution	Constructs accurate non-routine mathematical model.	Constructs model containing conceptual errors.	Fails to formulate mathematical representation.
Implementing the Plan	Execute steps accurately; sustains focus throughout productive struggle.	Execute steps inaccurately; exhibits declining task persistence.	No attempt to execute plan.
Reviewing the Results	Verifies logical consistency and domain validity.	Unable to evaluate errors independently.	No review performed.

Table 4 shows that the comparative analysis across Polya's framework for Question 2 highlights pronounced disparities in cognitive processing, strategic execution and emotional regulation across Adversity Quotient (AQ) profiles. Climbers (SCL) demonstrate high mathematical maturity and metacognitive control, accurately identifying structural constraints, constructing non-routine models, executing procedural steps flawlessly during productive struggle and validating solutions for domain consistency. Conversely, Campers (SCA) exhibit a partial problem-solving structure; despite identifying known values, they formulate conceptually flawed models, execute steps inaccurately as persistence declines and lack independent error-evaluation capabilities. Meanwhile, Quitters (SQU) experience cognitive paralysis and affective barriers, processing only surface-level numbers, failing to construct mathematical representations and abandoning execution and verification entirely. Consequently, higher AQ levels intrinsically drive mathematical resilience, error monitoring and sustained

cognitive engagement in non-routine task performance.

Discussion

The empirical findings of this study demonstrate that Adversity Quotient (AQ) serves as a potent predictor of HOTS performance in mathematics. However, interpreting AQ in isolation oversimplifies the psychological architecture of mathematical problem-solving. By locating AQ within broader construct networks, these results show that AQ typologies represent distinct configurations of mathematical resilience, self-efficacy, mathematics anxiety, self-regulated learning (SRL), metacognition and productive struggle.

As shown in Figure 2, non-cognitive attributes directly govern mathematical problem-solving performance through a structured psychological pathway. The framework illustrates how self-efficacy, metacognitive monitoring and self-regulated learning mechanisms synergistically mitigate mathematics anxiety, drive productive struggle and ultimately determine HOTS success.

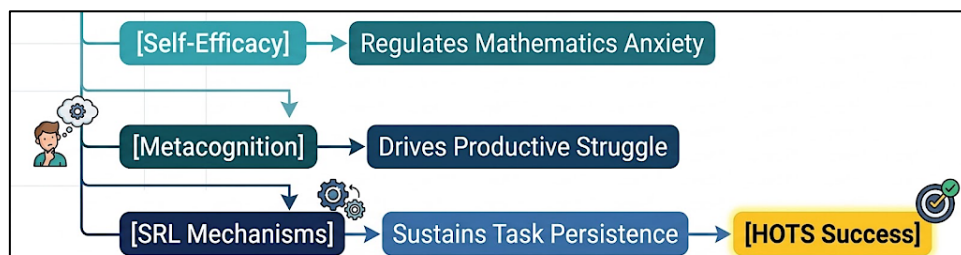


Figure 2: Mathematical Resilience/Adversity Quotient (AQ) Framework

The Critical Transition: from Comprehension to Productive Struggle

A pivotal finding of this study is that all subjects—regardless of AQ classification—demonstrated comparable proficiency in the initial Polya stage (understanding the problem). Restating text conditions relies on basic reading literacy and lower-level cognitive processing. The performance gap emerges at the solution planning stage, where concrete problem statements must be translated into abstract algebraic representations.

This phase boundary represents the onset of productive struggle. Translating non-routine contextual problems into system equations ($3x + 2y = 15,000$) induces cognitive friction. For Climbers (SCL), high self-efficacy acts as a buffer against cognitive strain, enabling them to perceive this friction as an intrinsic component of problem-solving. Conversely, Quitters (SQU) interpret cognitive friction as a threat to personal competence. High mathematics anxiety saturates working memory resources, converting cognitive strain into affective paralysis (41-43). Thus, SQU's failure at the planning stage stems not from lack of intelligence, but from an inability to regulate affective disruption during productive struggle.

Metacognitive Regulation vs. Procedural Decay

The contrast between Climber and Camper profiles underscores the role of metacognitive monitoring and self-regulated learning (SRL) during plan execution and evaluation. Campers (SCA) possess adequate baseline procedural knowledge; however, their persistence is conditional. As calculation complexity escalates, SCA subjects experience cognitive fatigue and progressive procedural decay. Lacking robust metacognitive control, SCA subjects fail to monitor their error trajectories, settling prematurely for incomplete or mathematically flawed solutions.

In contrast, Climbers (SCL) deploy mature metacognitive control mechanisms. When encountering calculation dead-ends during execution, SCL subjects do not surrender; instead, they activate independent backtracking—re-evaluating their operational assumptions and re-substituting variable values into the original equations. This self-correcting behavior exemplifies mathematical resilience, proving that sustained task persistence relies on the metacognitive capacity to regulate

one's own cognitive processing under pressure (44-46).

Deconstructing the AQ Typologies through Integrated Constructs

Quitters (Low AQ): Characterized by low self-efficacy and high mathematics anxiety. Their problem-solving profile is defined by avoidance coping and premature cognitive surrender. Instructional interventions for Quitters must prioritize early affective scaffolding and linguistic simplification to lower anxiety barriers before introducing complex mathematical abstraction.

Campers (Moderate AQ): Characterized by functional self-efficacy in routine contexts but limited self-regulated learning (SRL) during complex tasks. They engage in productive struggle up to a comfortable cognitive threshold. Interventions for Campers should focus on persistence training and multi-step metacognitive scaffolding to prevent procedural decay.

Climbers (High AQ): Characterized by high mathematical resilience, robust self-efficacy, active metacognitive monitoring and low affective disruption. They embrace productive struggle as a vehicle for growth. Advanced instruction for Climbers should emphasize non-routine, multi-solution tasks that further expand their metacognitive flexibility.

Conclusion

This qualitative inquiry reveals an emerging empirical pattern illustrating how Adversity Quotient (AQ) interplays with mathematical resilience, affective control and metacognitive monitoring when students tackle Higher-Order Thinking Skills (HOTS) tasks. Rather than establishing a universal law regarding AQ and mathematical achievement, these findings delineate nuanced typological profiles observed during Polya's problem-solving stages. Within this cohort, performance divergence across AQ categories (Climbers, Campers and Quitters) becomes particularly salient during the solution planning phase—the onset of productive struggle. While baseline problem comprehension was comparable across participants, only the Climber subject consistently demonstrated mature metacognitive regulation (independent backtracking and error verification) under cognitive pressure. Conversely, the Camper subject exhibited conditional persistence that declined

with procedural complexity and the Quitter subject experienced early cognitive anxiety, relinquishing effort during initial literacy interpretation. Pedagogically, these emerging qualitative patterns underscore the value of differentiated instructional scaffolding tailored to students' affective and metacognitive needs.

Despite these insights, several limitations of this study must be acknowledged. First, the small sample size inherent in this qualitative case study limits the statistical generalizability of the findings across larger, socio-demographically diverse student populations. Second, the investigation was restricted to the domain of System of Linear Equations in Two Variables (SPLDV), which primarily emphasizes algebraic problem-solving and may not fully capture cognitive-resilience dynamics in mathematical topics with higher spatial or abstract demands.

To address these limitations, future research should pursue large-scale experimental interventions (e.g., evaluating the longitudinal impact of Problem-Based Learning integrated with resilience-building scaffolding) to establish causal relationships and generalizable patterns between AQ enhancement and HOTS attainment. Furthermore, future studies should extend this qualitative and quantitative framework to higher-abstraction mathematical domains, such as spatial geometry and calculus, to verify the cross-domain consistency of AQ as a predictive construct.

Abbreviations

AQ: Adversity Quotient, ARP: Adversity Response Profile, CO₂RE: Control, Origin and Ownership, Reach and Endurance, HOTS: Higher-Order Thinking Skills, SCA: Camper, SCL: Climber, SPLDV: System of Linear Equations in Two Variables, SQU: Quitter.

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Author Contributions

Rezki Ramdani: Conceptualization, Methodological Design, Fieldwork, Data Analysis, Manuscript Drafting, Critical Revision, Suradi Tahmir: Conceptualization, Supervisory Oversight, Validation, Critical Revision, Jafaruddin: Resource Provision, Validation, Critical Revision. Every author endorsed the submitted version, assumes accountability for the entirety of the work and shares collective responsibility for ensuring its scholarly rigor.

Conflict of Interest

The authors confirm that no competing interest exists in relation to the publication of this work.

Data Availability

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

Declaration of Artificial Intelligence (AI) Assistance

During the preparation of this manuscript, the authors utilized generative AI tools (OpenAI ChatGPT and Google Gemini) exclusively for linguistic polishing, grammatical refinement and initial graphical conceptualization to enhance overall readability. All core intellectual contributions, including the research design, dataset curation, empirical analyses and data interpretations—were independently developed, rigorously reviewed and validated solely by the research team. Consequently, the authors maintain full oversight and assume sole responsibility for the originality, technical accuracy and scientific integrity of all text, figures and findings presented in this work. The authors take full responsibility for the content's originality, interpretation and accuracy.

Ethics Approval

Ethical clearance for this study was formally granted by the Research Ethics Committee of Universitas Negeri Makassar. Prior to the commencement of data collection, the research team ensured that comprehensive written informed consent was secured from every participant, confirming their voluntary participa-

tion, awareness of the study's scope and the guaranteed confidentiality of their data.

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