Kognitif
Jurnal Riset HOTS Pendidikan Matematika
Volume - 6 No - 3 2026 Page 1344 – 1359
ISSN 2776-9704 P-ISSN 2776-9984
https://doi.org/10.51574/kognitif.v6i3.4982

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How to cite: Sudiman, A., Habsyi, R., & Soamole, L. (2026). Mathematical Communication Skills of Students with Adversity Quotient Personality in Solving Story Problems Reviewed from Information Processing Theory. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, *6*(3), 1344–1359. https://doi.org/10.51574/kognitif.v6i3.4982

To link to this artcle: https://doi.org/10.51574/kognitif.v6i3.4982

Opened Access Article

Published Online on 01 September 2026

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Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i3.4982 Volume 6, No 3, July - September 2026, pp. 1344 –1359

Mathematical Communication Skills of Students with Adversity Quotient Personality in Solving Story Problems Reviewed from Information Processing Theory

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Article Info

Article history:

Received Apr 26, 2026
Accepted Aug 06, 2026
Published Online Sep 01, 2026

Keywords:

Communication skills
Mathematics
Story problems
Adversity Quotient
Information Processing Theory

ABSTRACT

This study investigates the cognitive mechanisms underlying students' mathematical communication in solving story problems by integrating Adversity Quotient (AQ) and Information Processing Theory. Although mathematical communication has been widely recognized as a key component of mathematical proficiency, limited research has explained how students' resilience-related dispositions shape the cognitive processes through which mathematical ideas are understood, organized, and communicated. A qualitative case study was conducted with 32 eighth-grade students at SMP Negeri 2 Halmahera Barat, Indonesia. Data were collected through validated open-ended story-problem tasks, AQ classification, students' written work, and semi-structured interviews. The analysis combined descriptive categorization of mathematical communication with thematic analysis based on four cognitive processing stages: attention, perception, retrieval, and encoding. The findings show that students' mathematical communication was generally low, with 17 students in the very low category. Cross-case analysis revealed distinct patterns across AQ profiles. Climbers demonstrated relatively complete cognitive processing cycles and coherent mathematical explanations. Campers showed partial processing, especially in strategy formulation, retrieval accuracy, and justification. Quitters experienced breakdowns from the attention stage, resulting in fragmented or absent mathematical communication. This study proposes a conceptual model in which AQ functions as a resilience-related regulator of cognitive processing continuity, thereby shaping mathematical communication outcomes. The findings contribute to mathematics education by offering a process-based explanation of communication difficulties and by emphasizing the need for instruction that supports both cognitive processing and resilience in problem solving.

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Introduction

Mathematical communication is a central competence in mathematics learning because students are expected not only to obtain correct answers, but also to interpret situations, express ideas through mathematical representations, explain procedures, and justify conclusions(Asmira Sudiman et al., 2023; Samura et al., 2024). This competence becomes particularly important when students solve story problems, since such tasks require students to transform verbal information into mathematical relations and then communicate the reasoning used to reach a solution (Harun et al., 2021; Rohid et al., 2019; Rusyda et al., 2020). In this context, weakness in mathematical communication is not merely a matter of inaccurate computation; it also reflects difficulty in understanding problem situations, selecting relevant information, organizing solution steps, and expressing arguments logically (M. Anggelina, 2023; Rusyda et al., 2020; Sudiman et al, 2024).

Empirical studies have consistently shown that students' mathematical communication remains a serious concern. Prior research reported that many students experience difficulty in identifying what is known and asked, representing mathematical ideas appropriately, and providing rational explanations for their answers (Kuncoro et al., 2023; Rohid et al., 2019; Satriani et al., 2025; Sudiman et al, 2024). Studies published in Kognitif: Jurnal Riset HOTS Pendidikan Matematika also indicate that mathematical communication is influenced by multiple factors. Differences in students' communication performance have been associated with gender(Satriani et al., 2025; Susanti et al., 2020; Tong et al., 2021), instructional media and learning design(Lase et al., 2025; Pitriani et al., 2024), as well as self-efficacy and self-esteem(Zaskiya et al., 2025; Zulkarnain et al., 2021). These findings are important, but most of them either compare outcomes across groups or examine the effectiveness of instructional interventions. Consequently, they do not yet explain sufficiently how communication difficulties emerge at the level of students' cognitive processing when they face contextual mathematical problems.

One factor that deserves closer attention in this regard is adversity quotient (AQ), because solving mathematical problems requires persistence when students encounter uncertainty, cognitive load, and potential failure. AQ distinguishes students who continue striving and adapting in the face of difficulty (climbers), students who stop at a moderate level of effort (campers), and students who tend to withdraw quickly when confronted with obstacles (quitters). Previous studies suggest that AQ is related to differences in students' mathematical performance, including creative thinking (Rusdyi et al., 2023), perseverance in mathematical reasoning(Rasyid et al., 2025), and mathematical representation (Rusmin et al., 2023; Wijayani et al., 2026). These findings imply that students' responses to difficulty are not peripheral to mathematical activity; rather, they may shape how students process information and externalize mathematical ideas. However, evidence that directly connects AQ with students' mathematical communication in solving story problems is still limited.

To explain such differences, outcome-based comparison alone is insufficient. A cognitive perspective is needed to identify how students attend to information, interpret problem situations, retrieve prior knowledge, and encode mathematical ideas into communicable forms. Information processing theory offers an appropriate analytical lens because it views problem solving as a sequence of mental operations through which incoming information is selected, interpreted, connected with prior knowledge, and expressed in response to task demands (Agustina, 2023; Fauziah et al., 2023). Within mathematical communication, disruption at any stage of this process may produce incomplete interpretations of the problem, inaccurate procedures, weak representations, or insufficient justification. Therefore, examining

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https://doi.org/10.51574/kognitif.v6i3.4982 Volume 6, No 3, July - September 2026, pp. 1344 –1359

mathematical communication through information processing theory allows a more precise explanation of where and why students have trouble.

The four operations used in this study are an analytical adaptation rather than a verbatim four-stage model proposed by Atkinson and Shiffrin. The classical information-processing account distinguishes sensory, short-term/working, and long-term memory systems together with control processes that regulate the flow of information (Atkinson & Shiffrin, 1968), while working-memory research emphasizes the temporary maintenance and manipulation of task-relevant information (Baddeley, 1992). For the present communication task, attention denotes selecting relevant problem information; perception denotes interpreting relationships and constructing a plan; retrieval denotes activating relevant knowledge from long-term memory; and encoding/response construction denotes organizing the processed information into written or oral mathematical representations. The final label is therefore a task-specific operationalization of response encoding, not a claim that external explanation is identical to long-term-memory encoding. These operations are analytically distinguishable but recursive and were selected because each leaves observable traces in written work and interview explanations.

Several relevant strands of research have developed, but they have largely progressed separately. On the one hand, studies have analyzed students' mathematical communication in story problems from the perspective of information processing theory (Sudiman & Habsyi, 2024; Uyen et al., 2021). On the other hand, research has shown that AQ is associated with important mathematical dispositions and performances, such as perseverance and representation (Rasyid et al., 2025; Wijayani et al., 2026). Nevertheless, the intersection of these two lines of inquiry remains underexplored. There is still limited evidence on how students with different AQ profiles process information at each stage when they are required to communicate mathematical thinking while solving story problems. This gap is theoretically significant because it concerns whether students' low communication performance stems primarily from conceptual limitations, from breakdowns in cognitive information processing, or from differences in resilience when dealing with difficulty.

Based on this gap, the study's primary contribution is a cross-case mapping of how mathematical communication is produced or disrupted across the four information-processing operations in students representing climber, camper, and quitter AQ profiles. The study does not test a causal effect of AQ and does not claim to validate a universal cognitive model. Instead, it develops a tentative explanatory proposition about how AQ-related persistence may support or interrupt the continuity of cognitive processing during story-problem solving. Accordingly, the study addressed three research questions: (1) What is the overall profile of eighth-grade students' mathematical communication in solving the story problem? (2) How do focal students representing climber, camper, and quitter AQ profiles differ in attention, perception, retrieval, and encoding/response construction? (3) What cross-case explanation links AQ-related persistence, continuity of information processing, and the quality of mathematical communication?

Method

Type of Research

This study employed a qualitative case study design. The design was selected because the purpose of the study was not to generalize statistically but to develop an analytical explanation of how students with different AQ profiles process information and communicate mathematical ideas when solving story problems. The case study approach allowed detailed examination of students' written work and interview explanations across cognitive processing stages.

Subjects

The screening cohort comprised 32 eighth-grade students at SMP Negeri 2 Halmahera Barat, Maluku Utara, Indonesia (11 boys and 21 girls). All students completed the mathematical communication task and the AQ questionnaire. Three focal participants were then selected purposively, one from each AQ profile, using four operational criteria: completion of both instruments; a written response that reflected the predominant communication pattern within the relevant AQ profile; sufficient verbal responsiveness to explain the written work during probing; and willingness and availability for follow-up interviews. The selection was intended to provide information-rich contrasts across cases, not representative estimates of all students in each profile.

Instrument

The instruments comprised an open-ended mathematical story-problem task, an AQ questionnaire, a three-indicator scoring rubric, and a semi-structured interview guide. Three candidate story-problem items were initially developed. Two mathematics-education experts reviewed their content relevance, language clarity, and alignment with the intended indicators: understanding the text, constructing a solution, and providing rational justification. The item judged most closely aligned with these indicators was selected for the main analysis. The same 0-3 analytic rubric was applied to each indicator for all 32 responses (maximum score = 9). Because the report did not document an inter-rater reliability coefficient, the score categories are used descriptively and are not treated as standardized test scores.

The AQ questionnaire contained 40 self-report statements contextualized to mathematics learning and organized around (Stolz's, 1997) CORE dimensions: Control, Origin and Ownership, Reach, and Endurance. Positively and negatively worded items were combined, with negatively keyed items reverse-scored on the Likert response scale. The available final report did not include item-level results or a current internal-consistency coefficient for this adapted version. Accordingly, the AQ classification is used only as a case-selection and cross-case comparison device; it is not interpreted as a newly validated psychometric measure or as an independent causal predictor.

The semi-structured interview guide was used to clarify the meaning of students' written responses and to elicit evidence that could not be inferred reliably from the written product alone. Open probes asked participants to explain what they noticed in the problem, how they interpreted the quantities and relationships, why they selected a procedure, what prior knowledge they recalled, and how they justified the conclusion.

Table 1. Research instruments

Tasks	Task Characteristics
Dina and Riko purchased different quantities of candies at different total prices. Dina bought three packages for a total of Rp12,000, while Riko bought five packages for a total of Rp20,000.	1. determine whether either buyer pays a lower unit price and justify the comparison; 2. calculate the amount of money needed if one individual purchases a specified number of candy packages; 3. represent the given information in the form of a table or a comparative graph; and 4. describe the steps taken in understanding, processing, and solving the problem.

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Tasks	Task Characteristics
The AQ instrument is a 40-item self-report questionnaire organized around Control, Origin and Ownership, Reach, and Endurance.	Items are contextualized to mathematics learning and use a Likert response scale. Positively and negatively keyed statements are combined, with negative items reverse-scored. In this study, the resulting profiles were used for purposive case selection and cross-case comparison.

Procedure

Data collection proceeded in three phases. First, all 32 students completed the story-problem task, and their responses were scored using the three mathematical communication indicators. Second, the AQ questionnaire was scored to establish the climber, camper, and quitter profiles used for purposive comparison. Third, the three focal participants took part in follow-up semi-structured interviews. During each interview, the participant's written response was used as an elicitation artifact: the interviewer asked the student to reconstruct how the information was noticed, interpreted, recalled, and expressed. The interviews served to triangulate the written evidence and to distinguish a missing written statement from a genuinely absent cognitive operation. This research procedure is illustrated in the Figure 1.

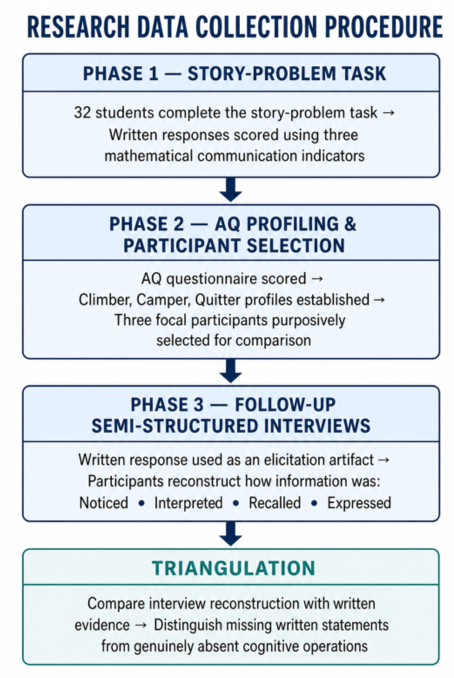

Figure 1. Research Procedure

Data Analysis

Data analysis was conducted in two layers. In the descriptive layer, each written response received 0-3 points for problem-text comprehension, solution construction, and rational justification. The total score was converted to a percentage and used to describe the distribution of communication categories across the 32 students. These counts were not used for inferential statistical testing. In the qualitative layer, analysis followed a structured thematic procedure (Braun & Clarke, 2006). The researchers first became familiar with each focal case by reading the written response together with the interview record. The data were segmented into meaning units and given provisional deductive codes for attention, perception, retrieval, or encoding/response construction; inductive subcodes captured specific successes, errors, hesitations, and justifications. Codes were organized into a case matrix, then compared within and across the three AQ profiles to develop themes concerning processing continuity and breakdown. The provisional themes were checked against the complete written and interview evidence and against the score-based communication category.

Operationally, an utterance or written segment was mapped to attention when it showed selection or restatement of known and requested information; to perception when it interpreted relationships, represented the situation, or formulated a plan; to retrieval when it recalled and applied a previously learned concept or operation; and to encoding/response construction when it organized steps, symbols, explanations, or conclusions for communication. A segment could receive more than one provisional code. When interpretations competed, the primary code was assigned according to the segment's function in the student's reasoning and was checked against the paired written or interview evidence. This decision rule reduced the risk of inferring a cognitive process from a single isolated statement.

Results

Overall profile of mathematical communication

The overall analysis of 32 students showed that students' mathematical communication skills were generally low. The assessment covered three indicators: ability to understand the problem text, ability to construct a solution, and ability to provide rational justification for the answer. The results show that only a small number of students reached high or very high categories. Five students were unable to understand the problem text, 11 students could write some known information but did not identify what was asked, 11 students identified known and asked information incompletely, and only five students identified the information completely. In the solution indicator, nine students were unable to solve the problem, 14 students wrote solution steps but made errors in applying them, eight students arranged steps correctly but obtained incorrect final answers, and only one student completed the solution accurately. In the justification indicator, 10 students were unable to provide rational explanations, 11 students provided partial explanations with errors, and 11 students provided relatively appropriate explanations although some still contained weaknesses.

Table 2. Categories of students' mathematical communication

Mathematical communication score (%)	Category	Number of students	AQ profile	Number of students
85.01- 100.00	Very high	1	climbers	4
70.01 - 85.00	High	3		
55.01 - 70.00	Moderate	9	campers	11
40.01- 55.00	Low	2		
0.00 - 40.00	Very low	17	quitters	17
Total		**32**		**32**

Table 2 indicates that 17 students were categorized as very low, two students as low, nine students as moderate, three students as high, and one student as very high. This distribution confirms that mathematical communication difficulties were not limited to computation. They appeared across problem comprehension, solution organization, and justification.

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Distribution of AQ profiles

The AQ classification identified three student profiles: quitters, campers, and climbers. The distribution is shown in Table 3.

Table 3. Distribution of Adversity Quotient profiles

AQ profile	Description	Number of students
quitters	Tends to disengage quickly when mathematical difficulty is encountered and may stop before constructing a viable solution.	17
campers	Sustains effort to a limited point but may accept a partial answer without further analysis, verification, or improvement.	11
climbers	Persists through difficulty, adapts the strategy when necessary, and continues until a defensible solution is produced.	4

Most students were classified as quitters (17 students). Eleven students were classified as campers, and four students were classified as climbers. This distribution suggests that many students tended to withdraw or reduce effort when facing mathematical difficulty, which is relevant to understanding their communication performance in story-problem solving.

Table 4. Relationship between mathematical communication category and AQ profile

Mathematical communication score (%)	Category	Number of students	AQ profile	Number of students
85.01- 100.00	Very high	1	climbers	4
70.01 - 85.00	High	3		
55.01 - 70.00	Moderate	9	campers	11
40.01- 55.00	Low	2		
0.00 - 40.00	Very low	17	quitters	17
Total		**32**		**32**

Table 4 shows a clear pattern: the four students in the high and very high communication categories were associated with the climber profile, the moderate and low categories were associated with campers, and the very low category was associated with quitters. This pattern should not be interpreted as a deterministic causal relationship. Rather, it provides empirical support for a process-based interpretation: students who persisted longer were more likely to sustain cognitive processing and communicate their reasoning more coherently.

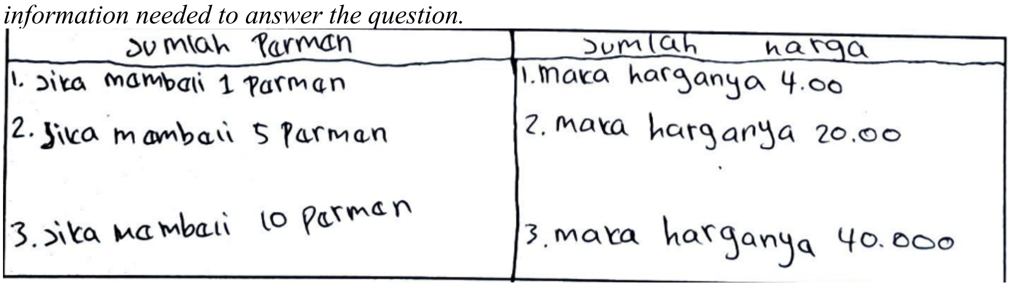
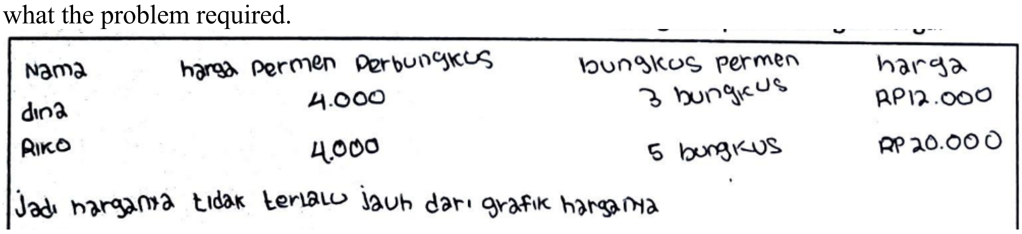
Cognitive *processing across AQ profiles*

The in-depth analysis of three focal participants revealed distinct information-processing patterns across AQ profiles. The findings are organized according to four interacting analytical operations: attention, perception, retrieval, and encoding/response construction.

Attention

Attention refers to students' ability to focus on the problem statement, read the information carefully, and identify what is known and what is asked. The climber demonstrated focused attention by reading the problem carefully and identifying relevant information. The camper showed partial attention, identifying some information but not elaborating it fully. The quitter failed to extract sufficient information from the problem statement. Details are presented in Table 5.

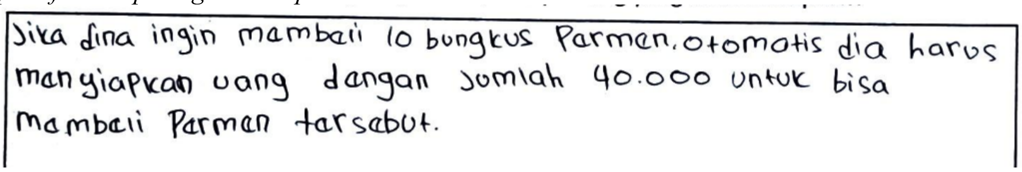
Table 5. Attention operation across AQ profiles

Information-processing operation	Evidence from written work and interview
	Climber AQ profile:
Attention	*The climber read the problem carefully, selected the relevant quantities, and recorded information needed to answer the question.*  Jumlah Parman | Jumlah harga 1. Jika mambali 1 Parman | 1. maka harganya 4.00 2. Jika mambali 5 Parman | 2. maka harganya 20.00 3. Jika mambali 10 Parman | 3. maka harganya 40.000 During the interview, the student accurately restated what was known and what had to be determined, confirming focused attention to the task.
	Camper AQ profile:
	The camper selected part of the relevant information but recorded it without fully elaborating what the problem required.  Nama | harga permen Perbungkus | bungkus permen | harga dina | 4.000 | 3 bungkus | RP12.000 RIKO | 4.000 | 5 bungkus | RP20.000 Jadi harganya tidak terlalu jauh dari grafik harganya During the interview, the student could restate the general intent of the problem but did not check whether all necessary information had been used.
	Quitter AQ profile:
	The quitter did not record sufficient information from the problem and could not state clearly what was known or asked.

Perception

Perception refers to how students interpret the problem and formulate a plan. The climber was able to transform problem information into a solution strategy. The camper showed hesitation and tended to proceed with spontaneous calculation without fully structuring the method. The quitter did not formulate a meaningful strategy. Details are presented in Table 6.

Table 6. Perception operation across AQ profiles

Information-processing operation	Evidence from written work and interview
	Climber AQ profile:
Perception	*The climber interpreted the quantities as unit-price relationships and constructed an explicit plan for comparing the two purchases.*  Jika dina ingin mambeli 10 bungkus Parmen, otomatis dia harus manyiapkan uang dangan jumlah 40.000 untuk bisa mambeli Parmen tarsebut. During the interview, the student explained the chosen representation and why the planned procedure could answer the question.
	Camper AQ profile:
	The camper recognized that a calculation was needed but hesitated about the method and moved directly to spontaneous computation without a fully structured plan.

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https://doi.org/10.51574/kognitif.v6i3.4982 Volume 6, No 3, July - September 2026, pp. 1344 –1359

	uang yang harus disiapkan Dina adalah Rp40.000, karena 1 bungkus permen seharga Rp 4.000. ~~Jadi 10x4 sudah mendapat 40 Rp 40.000~~ During the interview, the student described beginning the calculation immediately rather than first representing the relationship between total price and number of packages.
	Quitter AQ profile:
	The quitter did not transform the problem information into a mathematical representation or a viable solution plan.

Retrieval

Retrieval refers to the activation of relevant prior knowledge. The climber retrieved appropriate concepts and operations to support the solution. The camper retrieved some relevant information but applied it inaccurately, resulting in computational or conceptual errors. The quitter failed to recall or apply relevant prior knowledge. Details are presented in Table 7.

Table 7. Retrieval operation across AQ profiles

Information-processing operation	Evidence from written work and interview
Retrieval	***Climber AQ profile:***
	The climber retrieved the relevant multiplication and division concepts and applied them to determine and compare unit prices.
	Dina Harus menyiapkaan uang Sebanyak 40.000 untuk mendapatkan ~~ut per~~ 10 bungkus Permen. During the interview, the student explained how previously learned arithmetic knowledge was recalled and used in the solution.
	Camper AQ profile:
	The camper recalled that division was required but applied the operation inaccurately, reporting Rp20,000 divided by 5 as Rp5,000 instead of Rp4,000.
	DK: Dina membeli 3 bungkus pemen dengan harga 12.000, jika dia membeli 1 bungkus maka harganya 4.000 DK: Riko membeli 5 bungkus permen dengan harga 20.000. Jika ia membeli 1 bungkus harganya 5.000 The interview confirmed that relevant prior knowledge was partially available but was not accurately executed or checked.
	Quitter AQ profile:
	The quitter was unable to retrieve and apply the required arithmetic knowledge and reported forgetting even a simple addition procedure during the interview.

Encoding

Encoding refers to students' ability to express the solution process and conclusion in a mathematically meaningful form. The climber explained the steps and conclusion clearly. The camper provided an incomplete explanation and tended to stop at what was immediately understood. The quitter was unable to provide a meaningful explanation for the answer. Details are presented in Table 8.

Table 8. Encoding/response-construction operation across AQ profiles

Information-processing operation	Evidence from written work and interview
	Climber AQ profile:
Encoding	*The climber organized the calculations into a coherent sequence and communicated the reasoning and conclusion in mathematically meaningful form.*
	Sata memahami soal dengan cara menghitungnta terlebih dahulu secara Manual lah Sata menjawabnta. sata mengolahnta dengan memikirkan soalnta dengan bijak. Sata menjawab soalnta karena sudah takin jawabannta tepat
	During the interview, the student explained the purpose of each step and connected the calculated unit prices to the conclusion.
	Camper AQ profile:
	The camper produced a partial explanation of the steps but did not communicate a complete, verified justification for the answer.
	langka² Saya dalam memahami, mengolah, dan menJawab adalah yang Paling utama adalah memahami Soal Yangdi berikan dan Saya mengolah Soal Seperti men cari Jawaban dan ~~dan~~ Saya menJawab Soal yang beri.
	During the interview, the student stated that only the immediately understood part was completed, without deeper analysis or verification.
	Quitter AQ profile:
	The quitter did not provide a meaningful written or oral explanation of a solution.

Cross-case synthesis

The cross-case comparison identified concrete differences in both the location and consequence of processing difficulties. The focal climber identified the relevant quantities and question, selected a unit-price strategy, retrieved the required arithmetic operations, and explained the conclusion coherently. The camper noticed part of the information and began calculating spontaneously, but the recalled operation was applied inaccurately: Rp20,000 divided by 5 was reported as Rp5,000 rather than Rp4,000, and the response stopped without adequate verification or justification. The quitter did not extract sufficient information, did not formulate a method, and reported difficulty recalling even simple operations, so no meaningful explanation was produced. Thus, the profiles differed not merely in final scores but in where processing continuity was sustained, weakened, or interrupted. This pattern supports a tentative process explanation; it does not establish that AQ caused the observed differences.

Discussion

This study extends existing research on mathematical communication by demonstrating that communication is not merely an outcome of cognitive competence but an emergent property of the interaction between cognitive processing and resilience-related factors. The overall finding that many students were in the very low communication category is consistent with previous research showing that students often struggle to interpret story problems, organize solution procedures, and justify their mathematical reasoning (Kuncoro et al., 2023; Rohid et al., 2019; Sudiman & Habsyi, 2024). However, the main contribution of this study lies

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not in confirming low performance but in explaining how such performance emerges through different cognitive trajectories.

From the adapted information-processing perspective, successful mathematical communication depends on coordinated attention, perception, retrieval, and encoding/response construction. The climber sustained these interacting operations and produced a coherent explanation. The camper entered the process but did not fully structure the strategy, apply retrieved knowledge accurately, or verify the conclusion. The quitter's difficulty selecting relevant information constrained subsequent interpretation, retrieval, and response construction. Because the operations can recur and influence one another, these patterns should not be read as a rigid linear sequence. They indicate where the available evidence first showed a consequential breakdown.

The proposed account therefore positions AQ as a possible resilience-related regulator of processing continuity, not as a direct cause of mathematical communication and not as an immutable personality label. In the present cases, persistence appeared to influence whether a student remained engaged long enough to interpret the problem, retrieve a relevant operation, check its application, and formulate an explanation. Conceptual knowledge, arithmetic fluency, task familiarity, and interview responsiveness remain plausible alternative or complementary explanations. AQ also needs to be distinguished from adjacent constructs. AQ, as operationalized through Control, Origin and Ownership, Reach, and Endurance, concerns a person's pattern of responding to adversity (Stoltz, 1997). Grit concerns perseverance and consistency of interest toward long-term goals (Duckworth et al, 2007); self-efficacy concerns task- or domain-specific judgments of one's capability; a growth mindset concerns beliefs about whether ability can be developed; and self-regulated learning refers to cyclical planning, monitoring, control, and reflection across cognitive, motivational, and behavioral processes (Panadero, 2017). These constructs overlap in persistence-related behavior but are not interchangeable. Because this study measured only AQ, it cannot isolate AQ's unique contribution from grit, self-efficacy, growth mindset, or self-regulation.

International evidence further cautions against treating any single resilience construct as a sufficient explanation of achievement. Duckworth, (2007) introduced grit as perseverance and passion for long-term goals, whereas a later meta-analysis found that perseverance of effort was more predictive than consistency of interest and that grit overlapped substantially with other traits (Crede et al, 2017). Growth-mindset effects on achievement are generally small and context-sensitive (Sisk et al, 2018), and evidence on academic self-efficacy shows a moderate association with performance without establishing simple one-way causality (Honicke & Broadbent, 2016). Reviews of self-regulated learning likewise emphasize iterative interactions among cognition, metacognition, motivation, and behavior (Panadero, 2017). The present findings add a more local process account: resilience-related engagement matters at identifiable points of mathematical communication, but it operates alongside knowledge and regulatory processes.

Instructional support can therefore be aligned with the observed processing operation. For attention, teachers can ask students to underline quantities and relations, state what is known and asked, and retell the problem before calculating. For perception, guided questions such as 'What does each number represent?' and 'Which table, diagram, or equation shows the relationship?' can support a coherent plan. For retrieval, worked-example comparison, brief recall prompts, and analysis of errors such as Rp20,000 divided by 5 can reactivate and verify prior knowledge. For encoding/response construction, explanation frames, peer explanation, and metacognitive prompts such as 'Why is this step valid?' and 'How did you check the answer?' can strengthen justification. Students who disengage early may need short, attainable steps and immediate feedback; partial processors may need alternative-strategy and verification prompts; students who sustain the full process can be challenged to generalize and critique solutions. These supports should respond to observed behavior rather than permanently labeling students by AQ profile. The resulting framework should be read as an analytically grounded proposition generated from one screening cohort and three focal cases. Its value lies in identifying where communication can break down and what evidence teachers can look for, not in predicting an individual student's performance from an AQ label. A stronger test of the proposition would require multiple tasks, repeated observations, larger numbers of cases within each profile, and designs that examine competing constructs and instructional change.

Conclusion

This study found that mathematical communication in story-problem solving varied with the continuity of four interacting information-processing operations. The focal climber sustained attention, perception, retrieval, and encoding/response construction and produced a coherent explanation; the camper sustained only part of the process and made an unverified arithmetic application; and the quitter's early attention and retrieval difficulties prevented a meaningful solution. The primary contribution is therefore a tentative cross-case process mapping in which AQ-related persistence may help sustain processing continuity. It is not evidence that AQ directly or exclusively determines mathematical communication. Pedagogically, support should target the operation at which evidence of difficulty appears problem-information and restatement prompts for attention, guided representation for perception, worked-example recall and error checking for retrieval, and explanation frames with metacognitive verification for encoding/response construction. These supports can be intensified or faded in response to students' observed engagement, without treating climber, camper, and quitter categories as fixed identities. The findings are limited by the single-school context, the use of one primary mathematical task, one focal participant for each AQ profile, reliance on a self-report AQ questionnaire whose current psychometric coefficient was not documented in the available report, and the interpretive subjectivity inherent in coding cognitive processes. The cross-sectional pattern and exact category alignment do not establish causality. Future studies should use multiple tasks and time points, include several participants per profile, report reliability evidence for the adapted AQ measure and agreement procedures for coding, examine adjacent constructs, and test whether operation-aligned instructional supports improve mathematical communication.

Acknowledgments

We would like to thank the Directorate of Research, Technology, and Community Service (DRTPM) for funding this research through the 2025 Beginner Lecturer Research Grant, based on decision letter number 214/LL12/PG/2025 and agreement number 026/R-6/LPPM.ISDIK-KR/2025. We also extend our appreciation to LLDIKTI Region XII Maluku and Maluku Utara and to the Institute for Research and Community Service (LPPM), Institut Sains dan Kependidikan Kie Raha Maluku Utara, for administrative and institutional support.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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https://doi.org/10.51574/kognitif.v6i3.4982 Volume 6, No 3, July - September 2026, pp. 1344 –1359

Auhor Contributions

The first author, A.S, conceived the research idea presented and collected the data. R.H. and L.S. were the supervisors in this research who actively participated in the development of theory, methodology, organization and analysis of data, discussion of results, and approval of the final version of the work. All authors declare that the final version of this paper has been read and approved. The total percentage of contributions to the conceptualization, preparation, and correction of this paper are as follows: A.S.: 40%, R.H.: 35%, and L.S.: 25%.

Data Availability Statement

The author declares that the data supporting the results of this study will be made available by the corresponding author, [A.S], upon reasonable request.

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