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Students' thinking process in solving Pythagoras problems: Piaget's theory in adversity quotient

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ABSTRACT

Mathematics involves abstract concepts that require more than memorization; it demands a deep-thinking process for true understanding. This study aims to analyze and describe the thinking processes of students in solving problems related to the Pythagorean theorem, using Jean Piaget's theory in the context of Adversity Quotient (AQ). The research design is qualitative, employing a descriptive approach. The participants were 32 eighth-grade students from SMP Negeri 2 Ngawi, East Java province, Indonesia in the 2022/2023 academic year, categorized into three AQ groups: quitters, campers, and climbers. Data collection methods included the Adversity Response Profile (ARP) questionnaire, think-aloud tests, and interviews. The data were analyzed following Miles and Huberman's model, which involves data reduction, presentation, and conclusion drawing. The results indicate: (1) Quitters displayed both assimilation and accommodation in understanding and planning problem-solving strategies, but relied on assimilation during problem-solving and review; (2) Campers primarily engaged in assimilation throughout understanding, planning, solving, and reviewing; (3) Climbers used assimilation for understanding, planning, and reviewing, but employed both assimilation and accommodation during problem-solving execution. These findings suggest that students' AQ levels influence their cognitive processes in mathematics problem-solving, with higher AQ individuals demonstrating greater flexibility in their thinking. This has implications for educators seeking to tailor instructional approaches to students' adversity responses, enhancing both cognitive development and resilience in learning.

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Introduction

Mathematics plays a critical role in both education and daily life. Mastery of mathematics not only helps students solve complex problems but also enhances logical thinking and reasoning skills (Khalid et al., 2020). According to the Regulation of the Minister of National Education of the Republic of Indonesia Number 22 of 2006, one of the key objectives of mathematics education is to develop problem-solving skills, including the ability to understand problems, design mathematical models, solve those models, and

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interpret the solutions (Hidarya et al., 2020). In achieving these goals, students exhibit diverse thinking processes when solving mathematical problems (Fülöp, 2015). It is crucial for teachers to understand how students think during problem-solving, as this helps identify the types of errors students make and their underlying causes (Zhang & Cai, 2021). Research by Maryanti and Qadriah (2021) indicates that eighth-grade students struggle with problem-solving, with low achievement in problem comprehension (48.75%), planning (40%), execution (7.5%), and solution checking (0%). Similarly, Fatimah (2020) shows that ninth-grade students' problem-solving abilities are at a medium level, with varying percentages across different stages of problem-solving.

These precedent studies reveal that students' problem-solving abilities, particularly in Mathematics, are generally low to medium across different regions in Indonesia. The same issue is observed among eighth-grade students at SMP Negeri 2 Ngawi, East Java province, Indonesia, especially concerning the Pythagorean Theorem. Preliminary interviews with teachers revealed that students face difficulties in comprehending the problems, simplifying complex problems, understanding the relevant formulas, applying problem-solving strategies, and drawing accurate conclusions. These challenges stem from an inadequate understanding of mathematical concepts (Fitriati et al., 2024). Consequently, students' learning outcomes in mathematics remain below the standard. In the recent assessment, the highest score was 85, the lowest was 50, and the class average was 68.9, which is below the minimum passing grade of 75. Only 46.9% of the students achieved the minimum passing criteria, while 53.1% did not meet the standards.

In the example of the student's answer shown in Figure 1, it is evident that the student made a mistake in formulating the problem-solving plan by incorrectly equating the length of BA with BD, both considered as 8 dm. This mistake led the student to misinterpret the problem. Specifically, while attempting to calculate the length of HB, the student treated HB as side a, DH as side b, and wrongly used the length of BD (8 dm) as side c in the Pythagorean theorem. Consequently, the student arrived at an incorrect solution of 9.43 dm. Additionally, the student provided a conclusion without properly checking or revisiting the answer to validate its correctness. The absence of an evaluation step, where the student should have reviewed the calculations and confirmed the solution, further emphasizes the lack of thoroughness in their problem-solving approach. This example highlights the importance of clarity in understanding geometric relationships and careful application of mathematical principles. Given these errors, the researcher is motivated to explore and analyze the problem-solving abilities of eighth-grade students at SMP Negeri 2 Ngawi, particularly focusing on their comprehension and application of the Pythagorean theorem. This will help identify common misconceptions and improve teaching strategies in mathematics.

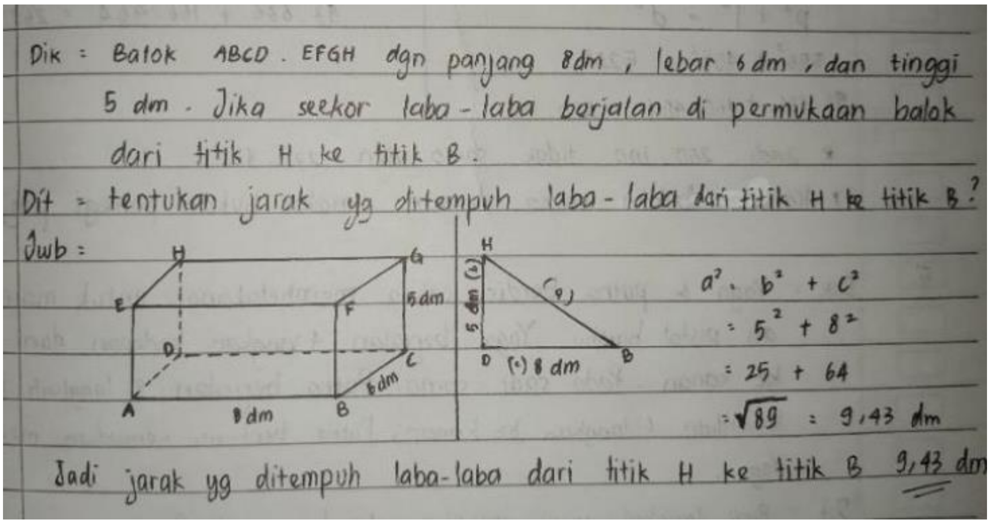

Figure 1. Example of students' answer on Pythagorean Theorem material

A study by Rahmawati et al. (2022) identifies several challenges students face when solving Pythagoras problems, such as difficulties related to geometry, triangle concepts, and performing root and power calculations. Solving mathematical problems requires students to engage in complex thinking processes (Lester Jr & Chai, 2016). These mental processes are critical in tackling challenging problems, yet many students struggle with them, resulting in poor performance (Jatmiko et al., 2023). Students' thinking processes vary depending on their individual abilities, and these processes can be observed through how the students solve mathematical problems (Fitriana & Waswa, 2024). Some students demonstrate a strong grasp of mathematical concepts, while others apply them without fully understanding, and still others attempt problem-solving without using any formal concepts.

Piaget's theory of cognitive development provides a valuable framework for understanding students' thinking processes in mathematical problem-solving. According to Piaget, thinking involves a series of mental operations triggered by incoming information, which interacts with pre-existing mental schemas (Mcleod, 2018). These schemas are shaped through assimilation and accommodation processes. Assimilation integrates new information into existing schemas, while accommodation involves modifying schemas to incorporate new or unfamiliar information (Swastika et al., 2023). Piaget's model emphasizes the continuous adaptation of schemas as students process new information, enhancing their cognitive development (Babakr et al., 2019). Accommodation, in particular, allows students to adjust their thinking to overcome novel challenges (Putri et al., 2021).

Research on students' mathematical thinking processes has evolved significantly. For example, Piaget's theory has been applied in various studies to analyze cognitive development in problem-solving. However, the role of non-cognitive factors, such as Adversity Quotient (AQ), in shaping students' problem-solving abilities remains underexplored. Stoltz (2005) introduced AQ as a measure of a person's resilience and ability to persevere through challenges. Subsequent research, such as by Na'imah et al. (2022), categorized individuals into three AQ types: Climbers (high AQ), Campers (medium AQ), and Quitters (low AQ), each representing different levels of persistence and problem-solving strategies. Although much is known about how AQ affects general problem-solving, fewer studies focus specifically on how AQ influences students' cognitive processes in mathematical contexts, particularly in solving Pythagoras problems.

Previous research has primarily focused on the cognitive aspects of problem-solving, such as conceptual understanding, error analysis, and schema adaptation, as noted in studies by Jatmiko et al. (2023) and Rahmawati et al. (2022). Although these studies provide valuable insights into students' thought processes, they often overlook how personal attributes, like resilience or AQ, play a role in problem-solving effectiveness. Existing research tends to examine cognitive development and mathematical strategies in isolation, without considering the interplay between cognitive and non-cognitive factors, such as a student's ability to endure and overcome difficulties. This gap highlights the need for more comprehensive studies that integrate both cognitive and non-cognitive frameworks in the context of mathematical problem-solving.

Despite the growing body of research, the specific relationship between Piaget's cognitive development theory and students' AQ in solving mathematical problems remains under-investigated. Most studies emphasize either cognitive aspects or non-cognitive factors, with few exploring how these dimensions interact to influence students' thinking processes. Understanding how AQ impacts students' ability to assimilate and accommodate new information while solving Pythagoras problems could provide valuable insights into improving teaching strategies and student performance. Addressing this gap could lead to more holistic approaches that combine cognitive theory with resilience training in mathematics education.

The purpose of this study is to explore the thinking processes of eighth-grade students in solving Pythagoras problems, using Piaget's theory of cognitive development and considering the role of Adversity Quotient (AQ). This research specifically aims to analyze the thinking processes of students categorized into three AQ types: Quitters, Campers, and Climbers. By integrating Piaget's theory with AQ, this study seeks to provide a more comprehensive understanding of how cognitive and non-cognitive factors influence students' mathematical problem-solving abilities. The findings are expected to contribute to the development of teaching strategies that address both cognitive skills and resilience in learning mathematics.

Method

In this study, the researchers employed a qualitative method with a descriptive approach, focusing on field observations. The data collected were analyzed non-statistically to provide an in-depth understanding of the subject matter. The research participants consisted of 32 eighth-grade students from class VIII H at SMP Negeri 2 Ngawi, East Java province, Indonesia during the 2022/2023 academic year. The students were selected based on three categories of Adversity Quotient (AQ): quitter (low), camper (medium), and climber (high). To categorize the students, an adversity response questionnaire was administered to assess their AQ levels. From the results of the questionnaire, a total of nine students were chosen to represent each AQ category, with three students from the quitter group (low), three from the camper group (medium), and three from the climber group (high). The categorization of these abilities is based on Stoltz's (2005) AQ model, as detailed in Table 1. This selection process ensured that the study examined a diverse range of students' problem-solving abilities in relation to their AQ levels.

The data collection techniques employed in this research included questionnaires, Pythagorean theorem problem-solving tasks, and think-aloud interviews. These methods were chosen to capture a comprehensive understanding of the students' thinking processes and their problem-solving strategies. The questionnaires helped to assess the students' adversity quotient (AQ), while the Pythagorean theorem tasks provided a practical context to observe how students approached mathematical problems. The think-aloud interviews offered insights into the students' cognitive processes as they verbalized their thoughts during problem-solving. Data analysis in this research refers to the systematic process of organizing and interpreting the collected data to extract meaningful insights and draw informed conclusions. As described by Miles and Huberman (1994), qualitative data analysis involves three key stages: data reduction, data display, and conclusion drawing. In the data reduction stage, irrelevant or redundant data is filtered out to focus on the most essential information. The data display stage involves organizing the data in a way that makes patterns and themes more apparent, often through visual aids like charts or tables. Finally, the conclusion drawing stage is where the researcher interprets the findings, identifying key insights and making connections to the study's objectives. This process ensures a thorough and reflective approach to understanding the research results.

Table 1. Ability Criteria for quitters, campers, and climbers

Category	**Score**
Quitters	0-94
Campers	95-134
Climbers	135-200

Results

The study was conducted at SMP Negeri 2 Ngawi during the even semester of the 2022/2023 academic year. The research participants comprised 32 students from class

VIII H. To identify each student's Adversity Quotient (AQ) type, all participants were administered the Adversity Response Profile questionnaire on Tuesday, May 23, 2023. The questionnaire aimed to categorize students into one of the three AQ types: Quitter, Camper, or Climber. The questionnaire was administered to the students after class and took approximately 45 minutes to complete. Every student in the class participated in the session, ensuring a comprehensive dataset. Upon analyzing the completed Adversity Response Profile questionnaires, the following distribution of AQ types among the students was observed (see Table 2).

Table 2. Adversity quotient type of the students

No	Type of Adversity Quotient	Number of Students	Percentage
1	Quitter	9 students	28.13%
2	Camper	17 students	53.12%
3	Climber	6 students	18.75%
	Total	32 students	100%

Table 2 indicates that 6 students (18.75%) were identified as Climbers, 17 students (53.12%) as Campers, and 9 students (28.13%) as Quitters. Based on these results, a purposive sampling technique was used to select 9 students to represent each AQ category, comprising 3 students from the Climber category, 3 students from the Camper category, and 3 students from the Quitter category. Following the selection of the nine subjects, a Pythagorean theorem description test was administered to assess their problem-solving abilities. The test aimed to gather insight into the students' thought processes while solving mathematical problems. To further deepen the analysis and understand the cognitive mechanisms at play, think-aloud interviews were conducted with all nine participants. This method allowed the researcher to observe how students verbalized their thinking, the strategies they employed, and any challenges they encountered during the problem-solving process. This qualitative data provided valuable insights into how AQ impacts students' mathematical reasoning and problem-solving approaches.

Thinking process of Quitter students in Pythagorean theorem problem solving

This section presents the findings on quitter-type students' thinking processes when solving Pythagorean theorem problems, based on Jean Piaget's theory and the results of think-aloud interviews. The three quitter-type students in this study, labeled as RR, JA, and RP, were given a set of problem-solving tasks and asked to read each problem in its entirety. These students were then asked to explain what they understood and the steps they took in solving the first, second, and third problems. Quitter students were able to grasp the information and solve problems to some extent, but they required a significantly longer time to process their thoughts. While working on the second and third problems, the quitter students read the problems but gave up before fully understanding them. They exhibited confusion when trying to comprehend the problem or when attempting to solve it. As a result, it can be concluded that quitter students engage in assimilation and semi-conceptual thinking processes when it comes to understanding problem-solving tasks. However, their approach to forming problem-solving plans was limited, as they failed to grasp the necessary methods and procedures for tackling the first, second, and third problems. When not explicitly prompted to perform manual calculations, quitter students were unable to proceed with solving the problem.

> "*I looked at the problem, but I didn't really understand how to start. I thought about it for a while, but I felt confused. I wasn't sure which formula to use, so I gave up before I could solve it.*" [RR]

> *"I read the problem, but I couldn't figure out what to do next. I tried to remember the steps, but nothing seemed to work, so I just stopped. I didn't even think about calculating anything."* [JA]

At the problem-solving stage, quitter students demonstrated incomplete accommodation thinking processes, which prevented them from successfully planning how to approach the given tasks. They did not attempt to formulate any strategies to solve the problems. This suggests that quitter students did not engage in either accommodation or semi-conceptual thinking processes when creating problem-solving plans. Consequently, even when provided with clear problem-solving steps, they could not produce any viable methods to solve the first, second, or third problems. As a result, quitter students were unable to solve the tasks assigned to them. During the problem-solving phase, quitter students struggled to decide which methods or steps to apply in solving all three problems. Since no valid solutions were generated, there was no need for them to verify or review their results. Therefore, quitter students relied on assimilation and semi-conceptual thinking processes in their initial understanding of the problems, but did not engage in computational thinking when it came to rechecking or validating their results.

> *"I didn't know how to plan the solution. I didn't understand the problem clearly, so I didn't make any effort to solve it. I just didn't know where to begin."* [RP]

Thinking process of Camper students in Pythagorean theorem problem solving

This section presents the thinking process of camper-type students in solving Pythagorean theorem problems based on Piaget's theory. The three camper-type students involved in this study were BA, EE, and ES. They were provided with a set of problem-solving tasks and asked to read each problem carefully. These students were then asked to explain what they understood and what steps they took in solving the first, second, and third problems. When solving essay-type mathematical problems related to the Pythagorean theorem, camper students' thinking processes began with how they responded to and approached the problems. Upon receiving the problem, camper-type students immediately started working on it. Their problem-solving process involved reading the problem carefully, explaining their understanding of it, and trying to interpret the question's requirements. Camper students did not seek additional information beyond what they already knew, relying solely on their prior knowledge. Consequently, camper students employed assimilation, conceptual, and relational thinking processes to understand the problem.

> *"I started solving the problem right away, but when I got to the numbers, I wasn't sure if I was using the right formula. I tried, but I think I made a mistake when I calculated it."* [BA]

In terms of planning the solution, camper students attempted to use the Pythagorean theorem formula to solve the problem. While they generally managed to solve the problem, they took a considerable amount of time to think and execute their plans. Their manual calculations led to minor errors, indicating a lack of precision in their solutions. In some cases, they misunderstood parts of the problem or felt confused about which version of the Pythagorean formula to apply. Therefore, camper students engaged in accommodation, semi-conceptual, and relational thinking processes during the planning phase. During the implementation of their solution plans, camper students struggled with accurately inputting values into the Pythagorean theorem formula, resulting in incorrect answers. Although they were able to carry out the steps of the solution, their imprecise calculations affected their final results. As a result, camper students demonstrated accommodation and semi-conceptual thinking processes in this stage. When reviewing their work, camper students showed an incomplete understanding of the process, as they were unable to fully verify or correct their answers. The imprecision in their calculations persisted, and they could not confidently reach a final solution. Therefore, camper students utilized accommodation and semi-conceptual thinking processes when rechecking their results.

> *"I understood the problem, but I got stuck when I tried to figure out which Pythagorean formula to use. I ended up guessing a bit and hoped it was right, but it took me a long time to figure out."* [EE]

> *"I could solve most of it, but when I checked my answer, I realized something was off. I wasn't sure how to fix it, so I just left it as it was."* [ES]

Thinking process of Climber students in Pythagorean theorem problem solving

This section explores the thinking process of climber-type students in solving Pythagorean theorem problems, based on Jean Piaget's theory. The three climber-type students who participated in this study were AD, GS, and AS. They were provided with a set of problem-solving tasks and asked to carefully read each problem. The climber students then explained what they understood and the steps they followed in solving the first, second, and third problems. When it came to understanding the problems, climber students quickly and accurately identified the known and unknown elements of each problem. They were able to determine the essential information needed to solve the problems without requiring additional data. Thus, climber students demonstrated assimilation, conceptual, and relational thinking processes as they processed the problem's requirements and understood the task at hand. In planning their problem-solving approach, climber students successfully wrote down the relevant formulas and outlined their step-by-step plan for solving the problems. They effectively summarized the given and required information, and were able to make detailed and accurate plans for each step of the solution. Climber students consistently applied the Pythagorean theorem to solve the problems. Therefore, it can be concluded that climber students went through assimilation, accommodation, and semi-conceptual thinking processes while formulating their solution plans.

> *"I knew right away which formula to use and how to approach the problem. I made sure to check everything step by step, and I went over my calculations again to make sure they were correct."* [AD]

> *"I didn't struggle much because I could see the problem clearly. I followed my plan, and when I was done, I went back and checked all my answers. It was important to me to get it right."* [GS]

During the implementation of their solution plans, climber students solved the problems accurately and methodically using a sequential and systematic strategy. They effectively applied their problem-solving strategies, calculating correctly with the Pythagorean theorem. As such, climber students employed accommodation, conceptual, and semi-conceptual thinking processes while solving the problems according to their pre-determined plans. When checking their results, climber students demonstrated precision and correctness by reapplying problem-solving strategies to ensure their answers were accurate. They performed a thorough verification process by recalculating their solutions and rereading the problems to ensure their answers aligned with the given information. Thus, climber students engaged in relational, conceptual, and semi-conceptual thinking processes to reconfirm the accuracy of their results. Interview data revealed that climber students approached problem-solving with persistence, without showing any signs of frustration or discouragement. They adhered to three stages—assimilation, accommodation, and equilibration (balancing)—and relied on semi-conceptual thinking processes to verify their results. Climber students consistently displayed determination, never giving up, and always aiming to achieve the best possible solution.

> *"I felt confident while solving the problems. I just made sure to stick to my plan and checked everything once more at the end to make sure I didn't miss anything."* [AS]

Discussion

The findings from this research revealed distinct thinking patterns among quitter, camper, and climber-type students in solving Pythagorean theorem problems. Quitter students demonstrated a lack of engagement in computational and conceptual thinking, becoming confused and giving up easily when faced with challenges. They struggled with problem-solving and showed minimal effort to explore different solutions. Camper students, while somewhat more successful, exhibited semi-conceptual thinking. They were able to solve problems but were often content with their first attempt and showed limited willingness to review or refine their solutions. Climber students, on the other hand, were highly motivated and displayed conceptual and semi-conceptual thinking processes. They approached problems methodically, showed persistence in solving them, and frequently reviewed their work to ensure accuracy.

In line with previous studies by Jannah (2023), quitter students tend to rely on intuition rather than formal concepts, leading to difficulties in problem-solving. Similar to the current study, quitter students did not exhibit accommodation or computational thinking processes, indicating confusion and slow cognition when receiving and processing information. This lack of engagement in critical thinking resulted in their inability to solve problems. The findings align with Awalludin (2024), which describe quitter students as disengaged learners who avoid deeper cognitive processes like accommodation and computational thinking. They are characterized by a lack of enthusiasm for learning, choosing to give up rather than face challenges.

The interview results further confirm these findings, revealing that quitter students were content with surface-level understanding and did not attempt to revise their answers even when prompted. This behavior supports Stoltz's (2005) theory, which identifies quitter-type individuals as those who retreat from challenges and avoid pushing themselves to find solutions. This unwillingness to engage in problem-solving was evident in their failure to apply computational thinking processes and their overall lack of perseverance (Pradika et al., 2029). In the context of learning mathematics, this tendency manifests as a reluctance to engage in deeper cognitive processes necessary for problem-solving (Wahyuningtyas et al., 2020). Quitter students often rely on rote memorization or familiar procedures without striving to understand underlying concepts (Sari et al., 2016). When faced with unfamiliar or complex problems, they exhibit a tendency to disengage rather than attempt new strategies or seek help. Their unwillingness to revise their work or explore alternative methods further demonstrates a fixed mindset, where they believe their abilities are static and unchangeable (Lailiyah & Kurlillah, 2023). This not only limits their ability to solve problems effectively but also hampers their growth in mathematical thinking, which requires perseverance, adaptability, and a willingness to make mistakes and learn from them.

In contrast, camper students demonstrated a willingness to engage in accommodation and semi-conceptual thinking processes. They showed enthusiasm for learning and were able to solve problems to a certain extent. However, they often became easily satisfied with their initial efforts and were reluctant to critically re-examine or improve their work. This finding is consistent with Stoltz's (2005) description of camper-type individuals, who tend to settle for mediocrity and are reluctant to push themselves further. The research findings align with studies by Aulia et al. (2020), which similarly describe camper students as engaging in accommodation and semi-conceptual thinking, but often lacking the motivation to critically review their solutions. While they may exhibit some problem-solving abilities, their lack of persistence prevents them from reaching their full potential (Putra et al., 2023).

Climber students, as described by the current research, showed the most advanced thinking processes. They engaged in assimilation, accommodation, and equilibration, demonstrating a high level of conceptual thinking (Fahrudin et al., 2024). These students approached problems with enthusiasm, systematically applied problem-solving strategies, and persistently reviewed their answers. This aligns with findings from Silvatama et al. (2023), Putri et al. (2023), and Dewi and Wutsqa (2024), who found that climber students are characterized by their resilience and determination to overcome challenges. According to Stoltz (2005), climber-type individuals are highly motivated learners who never give up in the face of difficulties and are always striving to find the best solution. This study's findings support Stoltz's theory, showing that climber students consistently applied themselves to understanding and solving the Pythagorean theorem problems through structured and thoughtful approaches. Venkatesh and Shivaranjani (2016) further emphasize that climber-type learners are not only talented but also deeply motivated, which was evident in the climber students' performance in this study.

The differentiation in thinking processes among the three student types highlights the role of cognitive and motivational factors in mathematical problem-solving. Quitter students' failure to engage in accommodation and computational thinking points to a broader issue of low motivation and cognitive dissonance. Their inability to persist in solving problems suggests that interventions focused on fostering resilience and improving self-efficacy may be necessary to encourage deeper engagement. In contrast, camper students, while possessing the capacity to solve problems, exhibit a psychological barrier to self-improvement. Their satisfaction with suboptimal solutions indicates a need for interventions aimed at fostering a growth mindset, encouraging students to see challenges as opportunities for further learning. Climber students, however, represent an ideal in problem-solving, demonstrating that a combination of motivation, resilience, and structured thinking leads to successful outcomes. This suggests that fostering such characteristics across all students could improve mathematical problem-solving abilities more broadly.

The findings from this study provide both theoretical and practical contributions. Theoretically, the research expands upon Piaget's cognitive development theory by linking it with Stoltz's adversity quotient (AQ) model, highlighting how different types of students process mathematical problems in unique ways. The study also reinforces existing literature on cognitive processes, providing empirical evidence on the distinct characteristics of quitter, camper, and climber students. Practically, the results of this study have implications for educators and curriculum designers. Understanding these different cognitive and motivational profiles can help tailor teaching strategies to meet the needs of various learners. For quitter students, fostering resilience and engagement through personalized support and active learning strategies could improve their problem-solving skills. For camper students, encouraging a growth mindset and promoting the value of revisiting and improving their work may lead to higher achievement. Finally, reinforcing and expanding the learning strategies used by climber students could serve as a model for developing persistence and deeper conceptual understanding across all students.

Conclusion

Based on the discussion, this study has identified significant differences in the thinking processes of climber, camper, and quitter students when solving math problems. Climber students, despite facing difficulties, demonstrate persistence and determination, consistently attempting to solve the problem and reviewing their work to find accurate solutions. Camper students also face challenges but tend to settle for their initial results without critically reviewing or improving upon them, showing a tendency to accept mediocrity. Quitter students, on the other hand, give up easily when confronted with obstacles, showing little to no effort in solving the problem. These different approaches significantly influence math learning outcomes. The climber students' perseverance and strategic thinking result in higher achievements, while the quitter students' lack of persistence leads to poorer performance. Camper students, who fall in between, exhibit moderate performance due to their partial engagement in problem-solving processes.

While this study has shed light on the cognitive processes of different types of students, there are some limitations that should be acknowledged. First, the research was limited to a small sample size of 32 students from a single school, which may not be representative of broader student populations. Future studies should consider involving larger and more diverse student groups to enhance the generalizability of the findings. Second, this study focused solely on the Pythagorean theorem. Expanding the scope to include other mathematical topics or subjects would provide a more comprehensive understanding of students' cognitive processes across different domains. Third, the research relied on qualitative methods, particularly think-aloud interviews, which may be influenced by students' verbal abilities. Future research could incorporate a mixed-methods approach, combining quantitative assessments with qualitative data to provide a more robust analysis of students' thinking processes. Practically, future studies should explore interventions aimed at fostering resilience and computational thinking in quitter and camper students, potentially improving their problem-solving abilities and learning outcomes. Additionally, longitudinal studies could investigate how these thinking processes develop over time and whether targeted teaching strategies can help shift quitter and camper students toward the climber mindset, ultimately improving their academic performance in mathematics.

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