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THE PERSISTENCE OF CLIMBER STUDENTS' MATHEMATICAL CONNECTIONS IN SOLVING HOTS PROBLEMS FROM AN ISLAMIC PERSPECTIVE

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ABSTRACT

Higher order thinking skills (HOTS) and the ability to connect various mathematical concepts are two crucial skills in the 21st century. However, students' success in mastering these two skills depends heavily on their Adversity Quotient and Islamic spirituality when facing difficult problems. This qualitative study aims to examine how Islamic values such as tafakur and itqan complement the four dimensions of AQ (control, origin & ownership, reach, and endurance) in "climber" type students when solving advanced math problems. The study involved two 9th-grade middle school students in Samarinda who demonstrated perseverance. Data were collected through math tests, worksheets, and in-person interviews. The results indicate that the "climber" students' persistence in connecting mathematical concepts does not stem solely from memorizing formulas but is driven by a combination of cognitive processes, AQ dimensions, and religious beliefs. The students demonstrated emotional control and mental endurance, preventing them from panicking when encountering a mental block. They took full responsibility (origin & ownership) and limited the impact of confusion (reach) to remain focused on solving problems meticulously. This attitude of not easily giving up reflects the teachings of patience, optimism, and hard work (QS. Al-Insyirah: 5–6). Meanwhile, caution and the habit of double-checking calculations are tangible manifestations of the principles of precision and perfection (itqan) (QS. Ar-Ra'd: 11). Therefore, mathematics teachers should not only teach formulas but also cultivate the AQ dimension and foster a character of itqan in their students.

Keywords: Adversity Quotient, Mathematical Persistence, Climber Students, HOTS, Islamic Perspective.

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PRELIMINARY

21st-century education is currently undergoing a shift in focus, from simply memorizing formulas to developing higher-order thinking skills (HOTS) (OECD, 2023; Rustika & Sati, 2025). These HOTS skills encompass complex thinking processes ranging from analyzing (C4) and evaluating (C5) to creating (C6) in order to solve non-routine

problems (Nurfauziyah et al., 2024). These skills are crucial so that students do not merely passively receive information but are also able to flexibly apply their knowledge to solve various real-world problems.

In the process of mathematical thinking, mathematical connection skills serve as the primary cognitive bridge that links separate ideas, concepts, and formulas into a single, holistic, and comprehensive understanding (Bicer et al., 2023). This ability encompasses the understanding to recognize relationships between mathematical ideas, link concepts that underlie one another, and apply them in daily life as well as in other disciplines (Adjie et al., 2020). Meanwhile, "mathematical connections" has several indicators, including understanding representations of the same concept, recognizing and utilizing the connections between mathematical ideas, and understanding how mathematical ideas are linked and built upon one another to form a complete system (Prihartiwi & El Milla, 2024; Yaniawati et al., 2019). These indicators are crucial for solving HOTS problems, particularly for the "analyzing" (C4) type of HOTS, which involves distinguishing, organizing, and attributing (Anggraini et al., 2019). Because complex problems cannot be solved in isolation, they require students to formulate word problems into algebraic form and apply various strategies to find valid solutions (Syah & Fathurohman, 2025).

However, the reality on the ground shows that students' mathematics proficiency in Indonesia remains a cause for concern. Based on national and international data, such as the PISA results (OECD, 2023) and the Minimum Competency Assessment (AKM) (Toni Toharudin, 2025), the majority of students have not yet reached the basic proficiency level, particularly on complex reasoning and problem-solving questions. Students generally struggle to translate word problems in geometry or algebra into mathematical models (Mandini & Hartono, 2018; Pradini, 2019). This weakness is influenced not only by a lack of mastery of basic material but also by affective factors such as resilience or Adversity Quotient (AQ) (Anwar et al., 2024; Yaniawati et al., 2019).

Students with a "climber" AQ type possess the strongest psychological resilience, driven by the four main dimensions of AQ (Kusumastuti & Nuriadin, 2021). First, the "control" dimension enables "climber" students to remain calm and maintain control over their emotions and cognitive actions when facing difficulties (Zubaidah Amir et al., 2021). Second, the "origin" and "ownership" dimensions foster a sense of personal responsibility to take the initiative in seeking solutions without blaming the complexity of the problem (Ilmiah & Utomo, 2020). Third, the "reach" dimension guides students to limit the impact of confusion so that it does not spread to other steps in the problem-solving process, thereby

helping them remain focused on distinguishing and organizing essential information (Rahayu & Ad, 2023). Fourth, the "endurance" dimension provides the mental resilience to view a deadlock as a temporary obstacle, which makes students refuse to give up, persistently recheck their work, and remain flexible in testing alternative algebraic strategies until a valid solution is found (Kurniawan, 2019).

From an Islamic perspective, this process of higher-order thinking and connecting mathematical concepts is, in essence, a tangible manifestation of the command to reflect (tafakkur)—that is, the full utilization of reason to understand the order and interconnections within Allah SWT's creation, as required in Surah Al-Baqarah (2:164) (Suntoro & Sahidin, 2021; Uyuni & Adnan, 2020). Furthermore, the psychological resilience demonstrated by "climber" type students through the AQ dimensions (control, origin, ownership, reach, and endurance) reflects the character of a mujahid and the principle of maximum effort (itqan). This aligns with the teachings of the Prophet Muhammad (peace be upon him) in Hadith by Muslim No. 2664 regarding the importance of being a strong believer and the necessity of diligence (itqan) in pursuing beneficial endeavors (Adha & Wantini, 2024; Andrianto & Rohmah, 2022).

Although studies on mathematical connectivity, Higher Order Thinking Skills (HOTS), Adversity Quotient (AQ), and the integration of Islamic values have been extensively conducted separately, as seen in Anwar et al., (2024), Hofifah et al., (2023), Imamuddin et al., (2025), Kurniawan, (2019), Supiarmo et al., (2021), Manazila et al., (2022), and Wahyuddin et al., (2021). However, no study has specifically investigated how the dimensions of Islamic spirituality (the values of tafakur and itqan) interact integrally with the "climber" type of Adversity Quotient in driving students' mathematical connection indicators when they encounter difficulties with HOTS problems. Most previous studies have merely positioned AQ as a technical predictor of learning outcomes or provided qualitative descriptions without examining spiritual motivation as a cognitive driver. Therefore, this study aims to fill this gap through an in-depth analysis titled: "The Persistence of Climber Students' Mathematical Connections in Solving HOTS Problems from an Islamic Perspective".

METHODS

This study employs a qualitative approach with a descriptive qualitative design. The study aims to provide an in-depth description of the mathematical connection persistence exhibited by "climber" type students when solving Higher Order Thinking Skills (HOTS)

problems at a junior high school in Samarinda. In this qualitative study, the researcher serves as the primary instrument, directly involved in the process of collecting, processing, and interpreting data in the field.

Research subjects were selected using purposive sampling based on their Adversity Quotient (AQ) level, as measured by the Adversity Response Profile (ARP) questionnaire a modified version of Stoltz (2000) as cited in Huljannah (2018). AQ scores are classified into three types: climber (High AQ: 166–200), camper (Moderate AQ: 95–134), and quitter (Low AQ: 40–59). The subject selection procedure began with the distribution of the ARP questionnaire to 39 ninth-grade students. Based on the results of the questionnaire, four students were identified as "climbers," and ultimately, two of these students were selected as research subjects. The selection of these two subjects was based on criteria of strong mathematical communication skills, as recommended by the mathematics teacher, as well as the students' willingness to openly share their thought processes during the study.

The data collection instruments were developed by the researcher and consisted of a modified ARP questionnaire, one non-routine HOTS test item, a worksheet, and a semi-structured interview guide. The selection of a single HOTS item aimed to allow for a focused, in-depth, and comprehensive analysis of students' cognitive processes, resilience, and persistence without inducing cognitive fatigue during the think-aloud procedure. All instruments were designed based on the integration of mathematical connection indicators, cognitive level C4 (analyzing) in Bloom's Taxonomy, and the AQ dimensions of persistence (control, origin and ownership, reach, and endurance). These instruments have been validated and deemed suitable for use following an expert evaluation process involving two validators: one mathematics education instructor specializing in mathematics content and one mathematics education instructor specializing in mathematics learning.

The indicators of persistence and mathematical connections among "Climber" type students in solving HOTS problems are measured through students' work processes integrated with the HOTS C4 cognitive dimension and the AQ dimensions. A detailed mapping of these indicators is presented in Table 1 below:

Table 1. Indicators of Persistence and Mathematical Connections in HOTS Task (C4)

Mathematical Connections	HOTS C4	Persistence (AQ)	Student Work Process
Understanding representations	Distinguishing	Control and Reach	1. Students begin reading the problem. 2. Students understand the problem presented in the question.

Mathematical Connections	HOTS C4	Persistence (AQ)	Student Work Process
of the same concept			3. Students realize that among the three tower diagrams in the problem, one is different. 4. Students mark the different tower image with a strike-through line.
	Organizing	Origin and ownership	1. Students begin to redraw the different shapes on the tower. 2. Students draw squares and rectangles on the worksheet. 3. Students connect the information from the problem to their existing knowledge.
	Attributing	Control	1. Students begin to define variables for the two shapes they previously redrew. 2. Students define *x* for the square image and *y* for the rectangle image. 3. Students count the number of squares in each tower. 4. Students count the number of rectangles in each tower.
	Distinguishing	Reach	1. Students write 4x on tower 1, 3x on tower 2, and 2x on tower 3. 2. Students write 3y on tower 1, 2y on tower 2, and y on tower 3.
Understanding and Using Connections Between Mathematical Concepts	Organizing	Control	1. Students construct the equation 4x+3y=56 from tower 1. 2. Students construct the equation 3x+2y=39 from tower 2. 3. Students construct the equation 2x+y=... from tower 3. 4. In the third equation for the third tower, students begin to think of ways to calculate the value being asked, which is the height of the tower.
	Attributing	Endurance	1. Students solve the problem presented in the question using a system of linear equations in two variables approach. In their work, students choose the most appropriate solution to obtain the final result.
Understanding How Mathematical Concepts Are Connected and Built Upon One Another to Form a	Distinguishing	Control	1. Students begin to select the method they are most proficient in.
	Organizing	Origin and ownership	1. Students begin to determine which variable to solve for first.
	Attributing	Endurance and Control	1. Students execute the entire calculation procedure using the SPLDV (System of Linear Equations in Two Variables) approach in a sequential, systematic, and highly precise manner using various methods.

Mathematical Connections	HOTS C4	Persistence (AQ)	Student Work Process
Comprehensive Whole			2. Students verify their work by reviewing the calculation steps as a form of self-proof. 3. Students draw a comprehensive final conclusion to answer the main question of the problem.

The data collection procedure was carried out in three main stages. First, ARP questionnaires were distributed to select "climber" type subjects. Second, "climber" type subjects completed one HOTS question while engaging in think-aloud, which was recorded using audiovisual equipment to observe their persistence and cognitive processes. Third, a semi-structured interview based on cognitive processes was conducted immediately after the subject finished the HOTS question to confirm and explore their thinking patterns in greater depth.

Teknik analisis data dilakukan secara kualitatif mengacu pada model Miles dan Huberman(Mardiana et al., 2020) yang meliputi reduksi data, penyajian data, dan penarikan kesimpulan. Data dari lembar pengerjaan, transkrip *think aloud*, dan hasil wawancara yang disaring, lalu disajikan secara naratif dan terstruktur untuk memetakan ketekunan koneksi matematis siswa hingga ditarik kesimpulan utuh. Untuk menjaga keabsahan data, peneliti menerapkan teknik triangulasi metode dengan membandingkan keselarasan antara jawaban tertulis, hasil *think aloud*, dan wawancara (Zalillah & Alfurqan, 2022), serta melakukan diskusi rekan sejawat guna menekan subjektivitas interpretasi peneliti (Ady, 2018; Hanik et al., 2023).

RESULTS AND DISCUSSION

This study involved two subjects categorized as "climbers" TSS1 and TSS2 and examined students' mathematical connection skills in solving HOTS problems, as identified through written worksheets, think-aloud protocols, and semi-structured interviews. An in-depth discussion of these skills will be presented in the following section:

1. Understanding representations of the same concept

In the early stages of problem solving (HOTS), "climber" students (TSS1 and TSS2) demonstrated mental resilience and a strong conceptual understanding through a combination of analytical thinking (C4), adversity quotient, and Islamic spiritual values. This thought process began at the differentiating stage, where TSS1 and TSS2 were able to parse the information in the image by distinguishing the shapes that made up the tower

rectangles and squares. Although initially confused, TSS1 actively asked questions to clarify the information. This process of asking questions and sorting images is a concrete manifestation of the "reach" and "control" dimensions (Huda & Mulyana, 2017; Saputra et al., 2021), in which students actively manage their confusion to prevent their thoughts from becoming scattered and to keep the complexity of the problem from extending beyond the context (Ibrahim & Sumaryono, 2019; Sudirman, A.,& Muttaqiyatun, 2018), thereby maintaining their focus to proceed to the next stage.

Upon entering the organizing stage, both students were able to transition from visual representations to mathematical symbols by independently assigning variables (x for the rectangle and y for the square), as shown in Figure 1 and Figure 2. TSS1 even tactically organized this information into a system of linear equations with two variables. This step of breaking down visual information into an algebraic model acts as a cognitive bridge that facilitates strategy planning (Kusumaningtyas et al., 2021; Supiarmo et al., 2021; Sugiarti et al., 2022).This activity is driven by the dimensions of "origin" and "ownership," which reflect a sense of self-responsibility and an intrinsic motivation within students to simplify problems, consistent with findings (Fahrudin et al., 2024; Hidayah & Prayitno, 2023) that students with "climber" characteristics are able to systematically formulate algebraic modeling plans when solving HOTS problems. Furthermore, during the attributing stage, students demonstrate a deep understanding of variable functions as precise measures, rather than mere guesswork. Students' careful re-reading of the question to ensure that the mathematical model they have created is on target underscores their high level of self-control in designing solution strategies (King, 2019).

From a religious and pedagogical perspective, the perseverance of "climber" type students in navigating the complexity of these HOTS problems reflects patience, optimism, and a strong fighting spirit in their efforts (Manazila et al., 2022). This resilient character aligns with the teachings of the Qur'an in Surah Al-Insyirah (94:5–6), which states that with every difficulty there is ease (Rahmatulloh et al., 2025). Students' efforts to seek clarity are a tangible manifestation of intellectual endeavor to transform ambiguous problems into clear scientific knowledge (Hadi & Ashari, 2020; Hardianto & Sucihayati, 2019). This finding offers a new perspective that enriches the body of research in mathematics education. It complements previous studies (Desthiani et al., 2024; Tama & Setyadi, 2022) by affirming that mental resilience (AQ) and religious values serve as the primary drivers that activate students' ability to connect geometric shapes to mathematical formulas. Therefore, mathematics teachers should not only teach how to calculate formulas but also cultivate

students' mental resilience and foster a character marked by diligence and meticulousness (itqan).

Figure 1

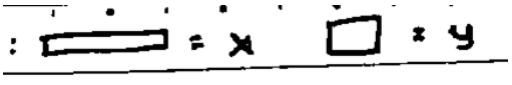

Figure 2

Figure 1 is important because it serves as authentic evidence of the transition from a visual representation (the image of the tower) to a written algebraic symbol. This figure demonstrates the subject's diligence in ensuring that no visual components were overlooked before proceeding to formal modeling. Figure 2 is important for showing the consistency of subject TSS2 in identifying algebraic symbols in written form. The clarity of these variable notations serves as the initial foundation for the subject to avoid conceptual errors in the subsequent stage of equation formulation.

2. Understanding and Using Connections Between Mathematical Concepts

In the stage of formulating a system of linear equations with two variables, the success of "climber" type students (TSS1 and TSS2) is not merely a matter of mechanically applying formulas, but rather the result of a combination of mathematical connection skills, analytical thinking (C4), adversity quotient, and Islamic spiritual values. This cognitive process begins at the differentiating stage, where TSS1 and TSS2 carefully sort the variable components of the diagram. TSS1 repeatedly calculates the components of tower 1 ($4x + 3y$), tower 2 ($3x + 2y$), and tower 3 ($2x + y$) manually, while TSS2 separates the calculations for each tower's components to anticipate the risk of modeling errors. This activity of sorting structural relationships is a manifestation of the "reach" dimension (Huda & Mulyana, 2017; Saputra et al., 2021), in which students ensure the precision of calculations so that minor errors do not carry over to the next step, while also limiting the complexity of the problem to prevent it from halting the thought process (Ibrahim & Sumaryono, 2019; Sudirman, A.,& Muttaqiyatun, 2018). This analysis of the relationships between coefficients and variables serves as the primary foundation for students to proceed to the model-building stage (Hikmah & Siswono, 2020).

Upon entering the organizing stage, both students were able to relate the number of components to the total height of the tower, formulating neat algebraic equations ($4x + 3y = 56$ and $3x + 2y = 39$), as shown in Figure 3 and Figure 5. This step of processing initial information into an SPLDV model ready for execution is driven by the "control" dimension, in which students demonstrate self-mastery in structuring algebraic ideas in a systematic manner without hesitation. The ability to link the characteristics of visual images with

algebraic concepts reinforces students' mastery of mathematical connections (Yunita et al., 2024). Furthermore, during the attributing stage, students do not rush to provide instant answers. TSS1 and TSS2 mapped out that to solve Tower 3 ($2x + y$), they must first find the specific values of x and y from the two initial equations in Figure 4 and Figure 6, where TSS2 identified the application of SPLDV material through both pure and combined elimination methods. The students' decision to determine the target formula earlier indicates the dimensions of endurance and control, where students tactically recall the most appropriate approach from their understanding and are prepared to tackle lengthy calculation steps until completion. This metacognitive activity confirms the argument by Börekci & Börekci, (2023) that, when executing a plan, subjects move adaptively based on a designed set of strategies. When encountering obstacles, students' active questioning and review of foundational concepts reflect a combination of the "reach" and "endurance" dimensions to access new information and integrate it into the solution process (King, 2019; Amir et al., 2021).

From a religious and pedagogical perspective, students' ability to relate SPLDV concepts to new problems reflects the maximum utilization of intellectual potential to engage in tafakur or deep thinking (Deciku et al., 2022). Students' steps in constructing mathematical models, defining variables, and selecting solution methods in a neat and organized manner are a concrete manifestation of the application of the value of itqan the principle of performing tasks earnestly, in an organized manner, and with high quality (Muchtar et al., 2021). These findings offer a new perspective that enriches the body of research on AQ-based mathematics education (Hofifah et al., 2023; Sukmaningrum et al., 2026), by demonstrating that mathematical connection skills, AQ (the "reach" and "endurance" dimensions), higher-order thinking skills (HOTS, C4), and Islamic spiritual values (tafakur and itqan) are interconnected as the primary drivers in formulating the SPLDV algebra model. For classroom instruction, these findings remind teachers of the importance of cultivating mental endurance and fostering a diligent attitude (itqan) in students, rather than merely requiring them to memorize formulas.

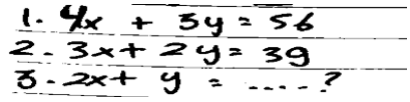

Figure 3

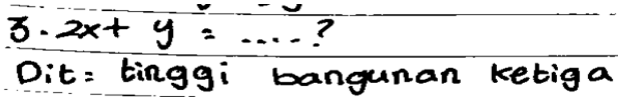

Figure 4

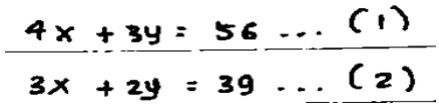

Figure 5

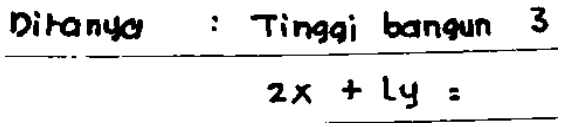

Figure 6

Figures 3 and 4 are particularly important because they confirm the subject's ability to systematically formulate mathematical models from visual stimuli. Figure 4 specifically shows the identification of the target equation (2x + y), which demonstrates the subject's persistence in directing all algebraic steps toward the correct solution. Figures 5 and 6 are important as physical evidence that subject TSS2 is capable of identifying the essence of the problem. The neat writing of the equations in Figure 5 and the formulation of the target equation in Figure 6 serve as evidence that the subject possesses a clear cognitive roadmap for solving HOTS problems.

3. Understanding How Mathematical Concepts Are Connected and Built Upon One Another to Form a Comprehensive Whole

Subjects TSS1 and TSS2 demonstrated the resilient mental characteristics of a climber through endurance, meticulousness, and the ability to independently double-check their results while solving problems. During the differentiation and organization stage driven by the AQ dimensions of control and origin TSS1 took full initiative by using a pure elimination method to minimize the risk of miscalculation. TSS1's perseverance was tested during the attribution stage through the AQ dimensions of endurance and control, where he remained focused on completing the coefficient multiplication and lengthy vertical subtraction in Figure 7 without giving up, then substituted the values of x and y into the target equation $2x + y = 22$ meters. On the other hand, subject TSS2 demonstrated strategic flexibility by choosing a hybrid method combining elimination and substitution in Figures 8 and 9, as it was deemed more practical and efficient. TSS2 consciously combined the two algebraic techniques to find the values of x and y, then substituted them into the target equation $2x + y = 22$ meters while verifying that the result met the problem's conditions. Figures 7, 8, and 9 serve as the primary physical evidence demonstrating a coherent, structured, and consistent algebraic solution process from start to finish.

The students' cognitive process began at cognitive level C4 for the indicators of distinguishing and organizing, driven by the AQ origin dimension. Students independently separated arithmetic operations and determined the correct coefficient multipliers before performing variable elimination (Mayfana et al., 2016; Zahid & Sujadi, 2017). These structured steps continue through the elimination process to obtain the value of the first variable, which is then substituted into one of the equations to find the value of the second variable (Irianti, 2020). The peak of C4 ability in the "attribution" indicator occurs when the found values of x and y are substituted into the target equation $2x + y$, yielding the final solution for the height of the third tower 22 meters which aligns with (King, 2019)

perspective on the ability to relate known information to the problem at hand. Motivation in the "origin" dimension is evident in students' self-awareness to take charge of the problem solving process without complaining about the difficulty of the problem, while the "endurance" dimension is demonstrated through consistency in calculations, precision, and a never-give-up attitude even when having to go through lengthy algebraic steps (Saputra et al., 2021).

From a religious and pedagogical perspective, this combination of psychological resilience aligns with the theological message of QS. Ar-Ra'd (13:11) that change toward better outcomes begins with one's own sincerity (Sany, 2019). The completeness of students' answers is a tangible manifestation of the value of itqan that is, a sincere, organized, and professional attitude in applying the knowledge of algebra bestowed by Allah SWT. These findings provide a new integrative perspective that complements previous studies (Desthiani et al., 2024; Hofifah et al., 2023; Sukmaningrum et al., 2026; Tama & Setyadi, 2022). While previous studies examined AQ separately as a differentiator of procedural step achievement, this study demonstrates that the C4 level of Higher-Order Thinking Skills (HOTS) (distinguishing, organizing, attributing), the dimensions of AQ (origin, control, and endurance), and Islamic spiritual values (tafakur and itqan) work together as the primary drivers that activate the mathematical connection abilities of "climber" students when facing critical points and problem-solving impasses. For classroom instruction, these findings underscore the importance of cultivating students' mental resilience and fostering a mindset of earnestness (itqan), rather than merely requiring them to memorize formulas.

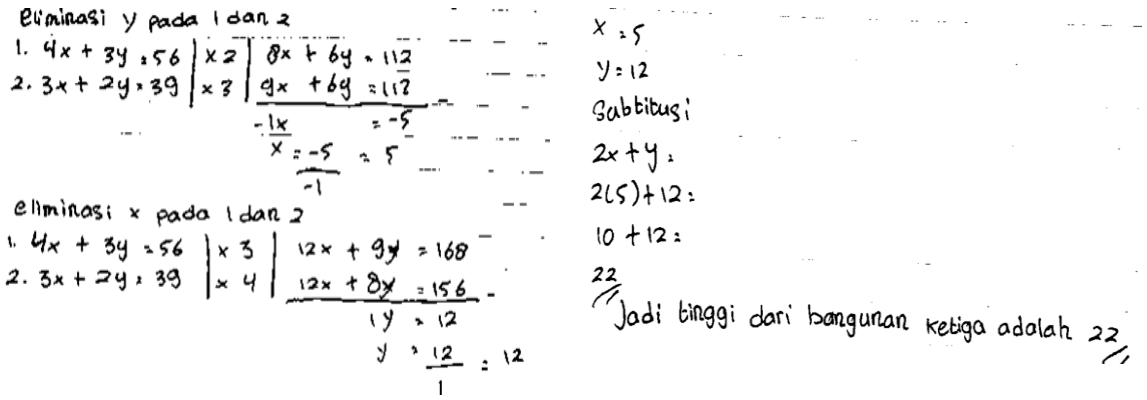

Figure 7

Figure 8

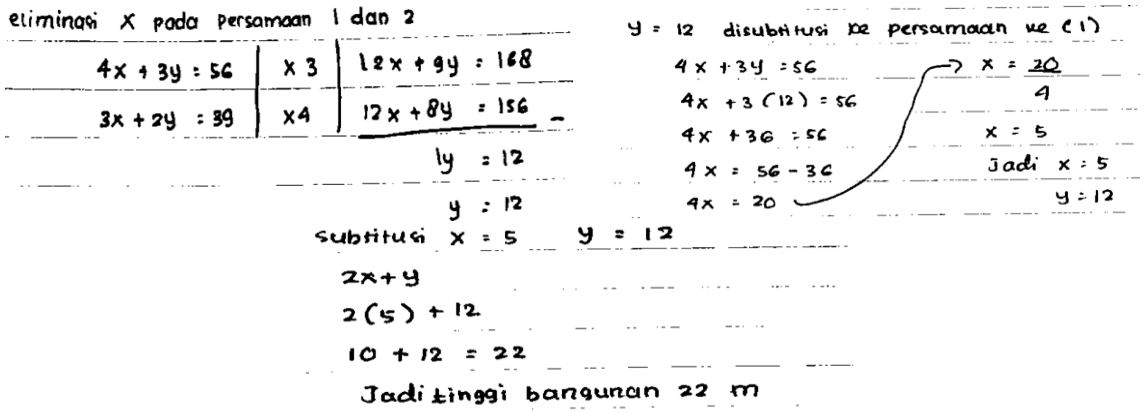

Figure 9

Figure 7 is the most significant evidence in this study. This figure shows a complete and highly systematic algebraic solution process. Subject TSS1's perseverance is evident in the neatness of the step-by-step elimination process, leading to the substitution of variable values back into the main question without any skipped steps. Figures 8 and 9 are crucial in demonstrating the flexibility of the strategy and the perseverance of subject TSS2. Figure 8 shows the initial design of the hybrid method, while Figure 9 demonstrates the successful execution of accurate, verified, and consistent algebraic calculations from start to finish.

CONCLUSION

This study shows that the success of "climber" students in solving HOTS problems is not merely a matter of memorizing formulas. Rather, this success stems from a mutually reinforcing combination of an analytical mindset, adversity quotient, and spiritual values such as diligence (itqan) and deep reflection (tafakur). "Climber" students have proven capable of maintaining a coherent and consistent train of thought, even when faced with complex problems that could potentially lead to a mental block. This mental resilience and these spiritual values serve as a powerful driving force that keeps students calm, encourages them to take risks, and prevents them from giving up easily."

This study offers a new perspective in the field of mathematics education by integrating cognitive aspects, psychological resilience, and spiritual values into a cohesive whole. These findings underscore that students' character and mindset play a crucial role in activating their understanding of mathematics. In practical terms, mathematics teachers are advised not only to require students to memorize formulas but also to cultivate mental resilience and foster a diligent attitude (itqan) through gradual, reasoning-based problem-solving exercises in the classroom.

Despite these intriguing findings, the scope of this study remains limited to two "climber" students working on systems of linear equations with two variables. Therefore, future researchers are encouraged to include student groups with different levels of perseverance (such as "campers" and "quitters"), test these concepts across other mathematical topics, and develop classroom teaching methods that intentionally cultivate students' mental resilience and spiritual values.

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