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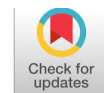
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Critical Thinking in Arithmetic: Insights from Qur'an-Memorizing Students

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ABSTRACT

This study aims to examine the categories of Qur'an-memorizing students in relation to their critical thinking ability when solving Higher-Order Thinking Skills (HOTS) problems, particularly in arithmetic. The significance of this research lies in understanding the relationship between Qur'an memorization—an activity that strengthens memory capacity—and students' critical thinking skills, which are essential for solving complex mathematical problems. This study explores whether Qur'an memorization can support the development of higher-order skills such as analysis and evaluation, which are crucial in mathematics learning. A descriptive qualitative approach was employed using HOTS test items and semi-structured interviews as instruments for data collection. Thematic analysis was applied to identify possible relationships among students' critical thinking ability, arithmetic problem-solving performance, and Qur'an memorization practices. The findings revealed that students in the high Qur'an memorization category exhibited less consistent performance in solving HOTS problems compared to those in the moderate and low categories. This suggests that while Qur'an memorization may enhance certain aspects of critical thinking, it does not necessarily guarantee proficiency in solving higher-order mathematical problems. The study provides new insights into how faith-based learning practices may influence students' cognitive development in mathematics and contribute to a broader understanding of the interaction between religious education and higher-order cognitive skills.



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Introduction

Critical thinking is a fundamental key to mathematical problem-solving. In the modern era, critical thinking has become one of the essential skills students must possess. Results from the Programme for International Student Assessment (PISA) reveal that many students encounter difficulties when solving problems requiring high levels of reasoning and analytical thinking. The PISA findings published by the Organisation for Economic Co-operation and Development (OECD, 2019) indicate that a significant number of students across various countries, including Indonesia, struggle to apply their general knowledge to solve complex problems. The 2013 Curriculum in Indonesia was designed to strengthen students' critical thinking abilities by promoting active and participatory learning. This aligns with the national educational framework that emphasizes critical thinking as a core skill for academic success. Sukenda (2016) states that critical thinking ability has a significant influence on students' mathematics achievement and can therefore be considered one of the determining factors of learning outcomes. Similarly, Puji Luritawaty et al. (2022) suggest that students' critical thinking ability can be observed through their academic performance. In summary, critical thinking represents a logical and objective way of reasoning in making decisions and solving problems.

Intellectual potential can be developed in various ways, one of which is through Qur'an memorization (*hifz al-Qur'an*). Memorizing the Qur'an is believed to enhance brain capacity because the process involves continuous memorization and repetition, which strengthens memory retention. Nawaz & Jahangir (2015) explain that memorization trains the brain through elaboration and visualization processes. Similarly, Romi et al. (2018) found that students' mathematics achievement can be influenced by Qur'an memorization activities since both require a high level of focus and concentration. Regular Qur'an memorization has a positive impact on students' cognitive and basic learning skills, as well as their academic achievement. According to Tarmuji et al. (2023), memorizing the Qur'an is a challenging process that demands strong concentration and persistence, requiring a specific technique that not everyone can easily master. Being a Qur'an memorizer (*hāfīz*) thus involves consistency, self-discipline, and emotional endurance.

Most Qur'an memorizers demonstrate excellent memory capacity and strong learning discipline. Research conducted by Binti Omar et al. (2020) concludes that Qur'an memorization can be classified as a Higher-Order Thinking Skill (HOTS) activity because it involves four interrelated components: Qur'anic reading, memorization, memory strength, and integration with other disciplines. Higher-order thinking in the learning process does not merely refer to remembering information, but rather to the cognitive integration of synthesis, analysis, association, and problem-solving. Within Bloom's taxonomy, the cognitive domain is categorized into six levels: C1 (Remembering), C2 (Understanding), C3 (Applying), C4 (Analyzing), C5 (Evaluating), and C6 (Creating). Qur'an memorization primarily aligns with the C1 level, remembering, which Bloom defines as the ability to recall facts, terms, and basic information. Students at this level can memorize verses of the Qur'an, including the chapter names, verse numbers, and text content. Meanwhile, at the C2 level, Ausubel (1968) describes understanding as the ability to relate new information to prior knowledge, allowing students to interpret and explain concepts. For instance, in arithmetic learning, students must not only memorize basic operations such as addition, subtraction, multiplication, and division but also comprehend how each operation works conceptually. Therefore, Qur'an memorizers are expected to possess enhanced critical thinking abilities when solving HOTS problems.

Tarmuji et al. (2023) also found a relationship between Qur'an memorization and academic performance, indicating that memorization may strengthen cognitive abilities and

make the academic learning process more efficient. Qur'an memorizers typically plan their study schedules and set daily targets, which involve time calculations to ensure their memorization progresses efficiently. This habitual calculation activity indirectly reinforces their arithmetic skills. Mayang Sari et al. (2018) state that arithmetic serves as a foundational branch of mathematics and plays a vital role in daily life, such as managing time and finances. Consequently, Qur'an memorizers with a higher quantity of memorization may exhibit stronger critical thinking ability when solving HOTS-based arithmetic problems.

Based on the preceding discussion, this study aims to identify the categories of Qur'an-memorizing students according to their levels of critical thinking ability and to analyze how they apply critical thinking when solving HOTS problems, particularly in arithmetic. In line with the growing recognition of the importance of intellectual and reflective capacities in education, this research provides new insights by exploring how Qur'an-memorizing students employ critical thinking in mathematical problem-solving, a topic that remains underexplored in educational research.

Method

Research Type

This study employed a descriptive qualitative research design, referring to the data collection techniques. The purpose of this research was to identify and analyze the categories of Qur'an-memorizing students in relation to their critical thinking ability when solving Higher-Order Thinking Skills (HOTS) problems in arithmetic. The study focused on developing an in-depth understanding of how Qur'an-memorizing students apply critical thinking in solving arithmetic problems.

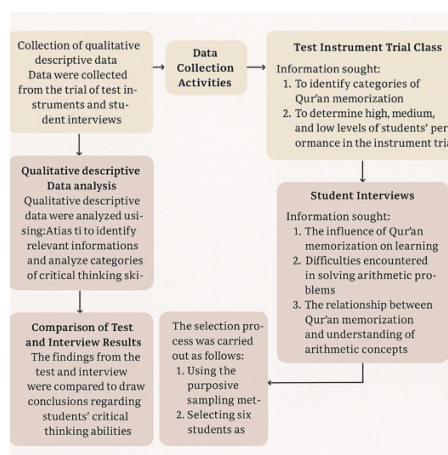


Figure 1. Data Collection Technique Flow.

Participants

Participants of this study were 29 eighth-grade students (Class VIII-D) from SMP Qur'an Darul Fattah, Bandar Lampung, Indonesia. These students were selected because they met the criteria of being Qur'an memorizers (*ḥuffāz*), who are expected to exhibit structured and disciplined thinking patterns developed through the memorization process. A purposive sampling technique was employed to select six students as subjects for semi-structured interviews. Among these, three students were chosen as representatives of the low, medium, and high Qur'an memorization categories. The selection of these subjects aimed to obtain a

deeper understanding of the critical thinking abilities of Qur'an-memorizing students in solving Higher-Order Thinking Skills (HOTS) arithmetic problems.

Instruments

Instruments used in this study consisted of a five-item HOTS (Higher-Order Thinking Skills) test and a semi-structured interview. The HOTS test was designed with reference to the PISA framework (Umami et al., 2021) and focused on arithmetic topics, which had been previously validated for content and construct validity. Following researchers who emphasize the role of interviews as a major data collection instrument in qualitative research, this study also employed non-test instruments in the form of semi-structured interviews.

The test instrument was administered to 29 Qur'an-memorizing students, while the interviews were conducted with six selected participants, including three key subjects representing the low, medium, and high levels of Qur'an memorization. The interviews aimed to explore students' conceptual understanding of arithmetic and how their Qur'an memorization habits influenced their critical thinking processes in solving mathematical problems. The essay-type HOTS test was designed to assess the students' critical thinking ability through arithmetic problems requiring higher-order reasoning, problem-solving, and interpretation of contextual information. The test items involved basic arithmetic operations and word problems aligned with critical thinking indicators such as explanation, inference, analysis, and strategy formulation.

Table 1. Test Instrument for Assessing Students' Critical Thinking Ability

No.	Problem	Critical Thinking Indicators
1	A fruit seller bought 12 durians and paid with three 100,000-IDR bills, receiving 30,000 IDR in change. (a) Determine the total purchase price. (b) Find the price per durian. (c) If the seller bought only eight durians, how much should he pay?	1. Giving simple explanations 2. Building basic skills 3. Drawing conclusions 4. Providing further explanations 5. Setting strategies and tactics
2	A melon seller bought 100 melons for 600,000 IDR. He sold 40 melons for 7,000 IDR each, 52 melons for 6,000 IDR each, and the rest spoiled. Calculate his loss.	Analysis, evaluation, and reasoning
3	A toy store sold 30 dolls for 387,000 IDR and made a profit of 60,000 IDR. Determine the purchase price per doll.	Logical reasoning and inference
4	A dozen pencils were purchased for 18,000 IDR and sold for 1,800 IDR each. Determine the amount of profit.	Problem analysis and computation
5	A fruit seller bought 40 watermelons. After selling them all, he suffered a loss of 10,000 IDR because the total revenue was only 110,000 IDR. Determine the purchase price per watermelon.	Evaluation, reasoning, and conclusion

Data Collecting and Analysis

The data were analyzed qualitatively using a thematic analysis approach, which aimed to identify the relationship between students' critical thinking abilities in solving arithmetic problems and their Qur'an memorization process. Thematic analysis was carried out through four systematic stages. The first stage involved repeatedly reading the students' critical thinking test results and Qur'an memorization data to gain a comprehensive understanding of the content and context. During this stage, the researchers examined the students' written responses, recorded essential observations indicating characteristics of critical thinking, and noted the alignment between their answers and their level of Qur'an memorization.

The second stage consisted of identifying and coding data based on the indicators of critical thinking ability. These indicators included: (1) giving simple explanations, (2) building

basic skills, (3) drawing conclusions, (4) providing further explanations, and (5) setting strategies and tactics. Each student's response was coded according to the corresponding indicator to facilitate grouping and further analysis. The third stage involved categorizing students into three groups based on their test scores, representing patterns of relationship between critical thinking ability and the level of Qur'an memorization: (1) Group 1 (High Memorization): Students who demonstrated systematic analytical skills and logical reasoning; (2) Group 2 (Moderate Memorization): Students who were able to understand concepts but were less consistent in applying reasoning; dan (3) Group 3 (Low Memorization): Students who tended to face difficulties in formulating problem-solving strategies. The final stage consisted of interpreting the results to describe the connection between Qur'an memorization levels and students' critical thinking abilities in solving arithmetic problems. In this stage, the researchers derived meanings from each group's characteristics and discussed how these categories interrelate to answer the main research question concerning the relationship between critical thinking and Qur'an memorization among students.

Results

Based on the categorization Table 2, it can be applied to measure students' critical thinking skills, where there were five students in the high category, nine students in the medium category, and fifteen students in the low category.

Table 2. Grouping Results by Score Category

No	Category	Students (PD)
1.	High	5
2.	Medium	9
3.	Low	15

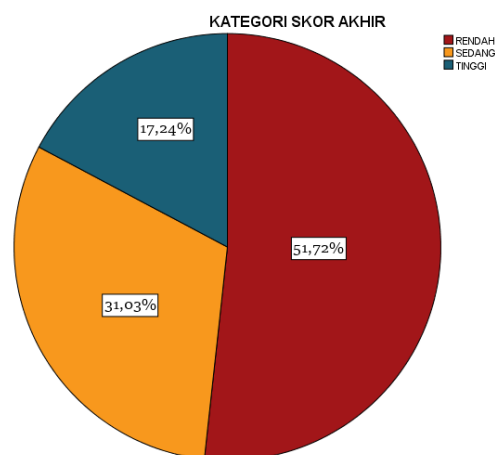


Figure 2. Percentage of Score Categories

After grouping the 29 students, the researcher selected three subjects. These subjects represented each level of Qur'an memorization category and were able to provide information regarding the critical thinking ability category of Qur'an-memorizing students in solving HOTS arithmetic problems. The score criteria are as follows:

Table 3. Criteria for Problem-Solving Ability Scores

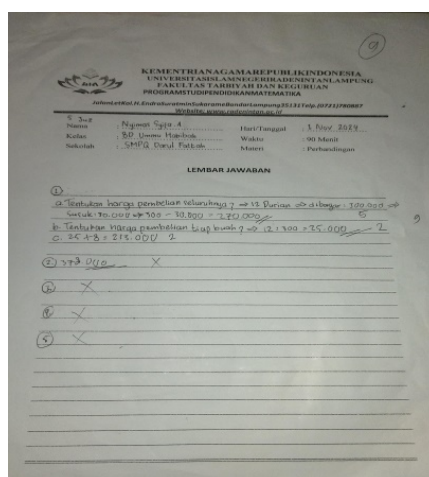
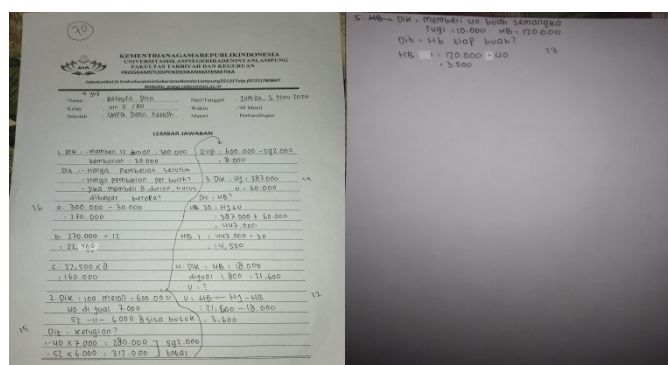
No	Category	Score Criteria
1.	High	71 – 85
2.	Medium	47 – 70
3.	Low	2 – 45

After analysis, the following coding results were obtained:

Table 4. List of Research Subjects

Code	Memorization Category	Mathematical Reasoning Score	Qur'an Memorized
PD_24	High	9	5 Juz
PD_23	Medium	70	4 Juz
PD_28	Low	85	2 Juz

Based on the research subject in the low memorization category (PD_28), the student was able to reach a high level of critical thinking indicators, able to explain the problem in detail, organize ideas well, provide explanations, and draw conclusions correctly. The medium memorization category subject (PD_23) met only some indicators of critical thinking, such as organizing ideas and drawing conclusions. Meanwhile, the high memorization category subject (PD_24) did not meet the critical thinking indicators, only rewriting one of the given problems.

**Figure 3.** Answer of PD_24**Figure 4.** Answer of PD_23

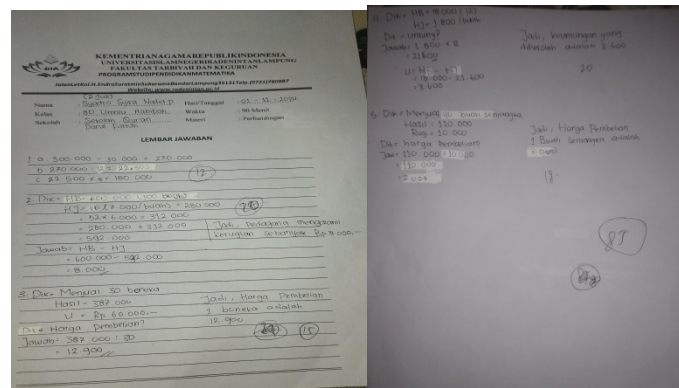


Figure 5. Answer of PD_28

Interview Results

Below is an excerpt from the interview with the high memorization category participant:

Q: Does the increasing number of memorized verses make it easier and more helpful for you to solve problems related to mathematics, or the opposite?

R1: “In my opinion, memorization doesn’t really help in mathematics because memorizing and learning math are different, so the way to understand them is also different. But for other subjects, it helps, especially Arabic.”

Q: Does memorizing the Qur’an make your learning process smoother or more difficult?

R1: “Because my parents focus me on memorizing, if my memorization is bad, all my studies are affected.”

Q: Based on the arithmetic test results, what aspect do you most want to improve?

R1: “To be more careful.”

Based on the interview with the high memorization category student (R1), it was found that memorizing the Qur’an does not directly support understanding in mathematics, as both require different learning approaches. R1 felt that memorization was more beneficial for verbal subjects such as Arabic. However, the strong focus given by parents on memorization sometimes interfered with concentration on other subjects when memorization targets were not met. Nevertheless, R1 showed good self-awareness by recognizing the need to improve accuracy in understanding arithmetic material. Below is an excerpt from the interview with the medium memorization category participant:

Q: Does the increasing number of memorized verses make it easier and more helpful for you to solve problems related to mathematics, or the opposite?

R2: “Yes, because the more I memorize, the better my memory gets. It helps me memorize formulas and other materials in mathematics.”

Q: Does memorizing the Qur’an make your learning process smoother or more difficult?

R2: “It doesn’t interfere with learning. During exams, there are many theories, so being used to memorizing makes it easier to study.”

Q: Based on the arithmetic test results, what aspect do you most want to improve?

R2: “I want to improve in division because I’m still not good at it.”

From the interview with the medium memorization category student (R2), it was found that increasing Qur'an memorization helps in the learning process, especially in remembering formulas and mathematical concepts. R2 believed that the habit of memorizing Qur'an verses trained memory, making it easier to recall both short-term and long-term material, especially during theory-based exams. R2 also stated that memorization did not hinder learning but rather helped in studying theoretical material. However, the student realized that the ability to perform division operations still needed improvement.

Below is an excerpt from the interview with the low memorization category participant:

Q: Does the increasing number of memorized verses make it easier and more helpful for you to solve problems related to mathematics, or the opposite?

R3: "Because the more we memorize, the more trained we are to remember or understand the material."

Q: Does memorizing the Qur'an make your learning process smoother or more difficult?

R3: "Sometimes it's difficult because we have to chase memorization targets while also preparing for daily tests."

Q: Based on the arithmetic test results, what aspect do you most want to improve?

R3: "The way to calculate profit and loss percentages."

Based on the interview with the low memorization category student (R3), it was found that memorizing the Qur'an helps in improving memory and understanding learning materials in general, including mathematics. However, R3 stated that memorization sometimes became an obstacle when it coincided with academic activities such as daily tests, making it difficult to manage study time. Nevertheless, R3 demonstrated self-awareness by identifying the need to improve understanding of profit and loss percentage problems.

Qualitative Analysis

Based on the interview analysis using Atlas.ti, several factors influence the critical thinking skills of Qur'an-memorizing students, as shown in Figure 6.

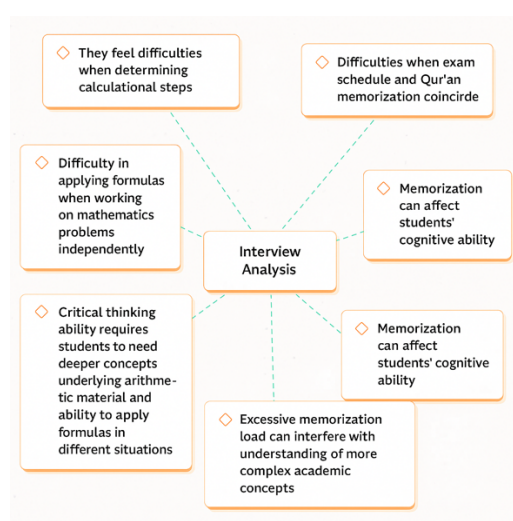


Figure 6. Students' Interview Analysis

Figure 6 illustrates the relationship between Qur'an memorization activities and students' critical thinking ability in solving arithmetic problems. Thematic analysis revealed that some

students experienced difficulty determining calculation steps and applying mathematical formulas independently. This was mainly due to a lack of conceptual understanding in arithmetic and the heavy memorization load. Students who focused too much on memorization tended to struggle with exams that required deep reasoning, especially when exam schedules coincided with memorization targets. Although memorization could improve memory retention, without proper time management and conceptual understanding, it could negatively affect cognitive ability and hinder mastery of more complex academic concepts.

Discussion

According to Nurhayati et al. (2023), students with a high level of Qur'an memorization tend to perform well in solving mathematical problems, including those categorized as Higher-Order Thinking Skills (HOTS) questions. This tendency is attributed to the enhanced memory retention and concentration developed through the memorization process. However, the findings of the present study diverge from this conclusion. As illustrated in Figure 3, students with the highest level of Qur'an memorization were not always able to solve HOTS problems perfectly. Conversely, as shown in Figure 5, some students with lower levels of memorization successfully completed HOTS questions. These results suggest that possessing a high level of memorization does not necessarily correspond to having a high level of critical thinking ability.

From the first interview question, it was revealed that critical thinking skills, such as analyzing information and evaluating problem-solving steps, can indeed develop through memorization practices. However, understanding mathematics, particularly arithmetic, relies more heavily on conceptual comprehension than on memorization alone. This finding aligns with Scheiner et al. (2022), who noted that while memorization may support certain cognitive abilities, the development of students' critical thinking requires a deeper conceptual understanding of arithmetic and the ability to apply mathematical formulas in varied contexts.

Responses to the second interview question indicated that some students felt burdened by the dual demands of memorization and academic study. This finding is consistent with Fuchs et al., (2020) and Hord et al. (2016), who found that an excessive memorization workload can hinder the comprehension of more complex academic concepts. Students who are overly focused on memorization often struggle when faced with examinations requiring higher-order reasoning and conceptual depth. The third interview question revealed that while memorization enhances memory capacity, applying formulas to solve mathematical problems demands more complex and critical cognitive processes. This supports the argument of Lee et al., (2018), who emphasized that a strong understanding of arithmetic concepts, such as profit and loss, enables students to devise effective problem-solving strategies. Memorizing formulas alone is insufficient for tackling high-level mathematical problems, which require critical thinking abilities such as interpreting problem contexts, selecting appropriate formulas, and applying them accurately within given scenarios.

Excessive memorization may also cause students to feel overwhelmed, thereby reducing their capacity to engage in critical thinking. The cognitive overload associated with extensive memorization can impede the comprehension of complex academic material. When students focus primarily on memorization, they may lack sufficient time to grasp underlying concepts, particularly when memorization schedules coincide with academic examinations. This overlap can lead to reduced concentration and increased academic stress, which ultimately affects their learning performance and critical thinking development. These findings highlight that memorization-based learning, while beneficial for cognitive discipline, should be complemented with conceptually rich learning strategies to nurture higher-order reasoning in mathematics.

Conclusion

This study concludes that Qur'an memorization does not necessarily correlate with higher levels of critical thinking in solving mathematical problems, particularly those requiring Higher-Order Thinking Skills (HOTS). While memorization practices strengthen concentration, discipline, and memory retention, they do not automatically enhance analytical reasoning or conceptual understanding. The findings demonstrate that students with moderate or even low levels of Qur'an memorization were sometimes more capable of applying critical thinking processes than those with higher memorization levels. This pattern indicates that the development of critical thinking in mathematics depends more on conceptual comprehension, reflective reasoning, and problem-solving experience than on memory capacity alone.

Theoretically, these findings expand the discussion on the intersection between religious cognition and mathematical cognition by showing that memorization-based intelligence (rote memory) must be complemented by higher-order cognitive strategies such as analysis, evaluation, and synthesis. This study reinforces Bloom's taxonomy framework, positioning Qur'an memorization primarily within lower-order thinking (C1–C2), while effective problem solving in arithmetic operates at the higher levels (C4–C6). Therefore, the integration of both domains, spiritual discipline through memorization and cognitive reasoning through mathematical practice, may create a more holistic model of intellectual development in Islamic education.

From a pedagogical perspective, the study suggests that mathematics instruction for Qur'an-memorizing students should emphasize conceptual scaffolding, guided reflection, and applied reasoning exercises rather than memorization of formulas alone. Teachers in Qur'an-based schools should design learning environments that bridge students' strong memory skills with tasks requiring logical inference, contextual interpretation, and argumentation. This alignment would allow students to transfer the discipline and focus gained through Qur'an memorization into critical and analytical thinking processes required in mathematics learning. Furthermore, educational institutions should consider curriculum integration that balances cognitive and affective development, combining spiritual values with analytical reasoning. Such an approach can cultivate learners who are not only spiritually grounded but also intellectually agile, capable of engaging in complex problem solving while maintaining ethical and reflective awareness. Future research could explore longitudinal studies or mixed-method designs to trace how sustained Qur'an memorization training influences the evolution of cognitive flexibility and reasoning patterns across different mathematical domains.

Conflict of Interest

The authors declare that there is no conflict of interest.

Authors' Contributions

B.H., S.A., and S.H.F. actively participated in the implementation of the research, including data collection, data analysis, interpretation of results, and manuscript preparation. Meanwhile, R.R.M. and B.S.A. provided guidance on the execution of the study, ensured methodological alignment, and approved the final version of the manuscript. All authors have read and approved the final version of this paper. The percentage contributions to the conception, writing, and revision of this article are as follows: R.R.M.: 25%, B.H.: 21%, S.A.: 21%, S.H.F.: 21%, and B.S.A.: 12%.

Data Availability Statement

The authors declare that data sharing is not applicable to this article, as no new data were created or analyzed in this study.

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