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# Exploring MTs students' errors in mathematical problem solving: A newman error analysis of madrasah science competition problems

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**Abstract**

**Background:** Mathematical problem solving in the Madrasah Science Competition (KSM) requires students to interpret contextual information, construct appropriate mathematical representations, perform accurate procedures, and communicate solutions effectively. However, difficulties at different stages of problem solving may hinder students' ability to successfully address competition-oriented mathematics problems.

**Aim:** This study aimed to explore MTs students' errors in solving KSM mathematics problems using Newman Error Analysis (NEA) and to examine their KSM participation experiences, study habits, and competition preparation.

**Method:** A qualitative case study was conducted with MTs students in Sleman Regency. Data were collected through mathematics problem-solving tests and questionnaires and analyzed using the Miles and Huberman framework through data reduction, data display, and conclusion drawing. Students' errors were classified into five NEA categories: reading, comprehension, transformation, process skills, and encoding.

**Results:** The findings identified all five NEA error categories, with encoding errors occurring most frequently (93%), followed by process-skill (85%), transformation (80%), comprehension (53%), and reading errors (37%). Students also demonstrated variations in prior KSM participation, competition preparation, and regular mathematics study habits, providing additional context for understanding their problem-solving difficulties.

**Conclusion:** The findings indicate that students' difficulties extend beyond reading and understanding problems to transforming information into mathematical representations, executing appropriate procedures, and communicating final answers accurately. Systematic and sustained problem-solving practice that integrates mathematical reasoning with Islamic contexts is therefore important for strengthening students' competence in solving KSM mathematics problems.

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## INTRODUCTION

Mathematics education in madrasahs is expected to develop students' critical and logical thinking while simultaneously connecting mathematical knowledge with the values embedded in Islamic education This distinctive orientation means that mathematics instruction should extend beyond the acquisition of arithmetic and procedural skills toward learning experiences that enable students to interpret and apply mathematical ideas within meaningful contexts (Imamuddin et al., 2020; Nasution et al., 2023). Such an approach is consistent with the broader educational mission of madrasahs, which emphasizes academic development alongside the formation of students' character and spirituality (Dahirin & Rusmin, 2024). Integrating Islamic values into mathematics learning can provide a contextual foundation through which abstract concepts are connected with situations that are more relevant to students' educational experiences The use of appropriate learning contexts is

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particularly important because contextualized instruction can facilitate students' understanding and strengthen their engagement with mathematical ideas (Ferede et al., 2026; Kusnirova et al., 2026; Utami et al., 2024). Meaningful contexts may also encourage students to move beyond memorizing formulas by identifying relevant information, recognizing relationships among quantities, and determining appropriate strategies for solving problems These processes are closely related to mathematical problem-solving competence, which requires the coordination of conceptual understanding, reasoning, procedural knowledge, and communication The ability to solve contextual mathematical problems is therefore an important component of students' numeracy development and their capacity to apply mathematics beyond routine classroom exercises This competence becomes increasingly important when students encounter unfamiliar or non-routine tasks that require flexible reasoning rather than the direct application of previously practiced procedures Accordingly, strengthening contextual mathematical problem solving represents an important component of mathematics education in madrasahs, particularly for students who are expected to engage with cognitively demanding academic activities.

One context in which these mathematical competencies are particularly required is the Kompetisi Sains Madrasah (KSM), or Madrasah Science Competition, which provides madrasah students with opportunities to demonstrate their abilities in scientific disciplines, including mathematics KSM functions not only as an academic competition but also as a setting in which students are challenged to mobilize mathematical knowledge, reasoning, and problem-solving strategies in problems that may incorporate Islamic contexts (Nawi et al., 2025; Umar et al., 2025; Yaakob et al., 2025) Competition-oriented and non-routine mathematical problems generally require students to move beyond familiar algorithms by interpreting complex information, constructing mathematical representations, selecting appropriate strategies, and evaluating the reasonableness of their solutions Previous studies have consequently examined different dimensions of non-routine problem solving, including students' problem-solving abilities, mathematization, creative thinking, and strategies for dealing with unfamiliar mathematical situations (Ergen, 2021; García-Moya et al., 2024; Kholid et al., 2024). Research has also emphasized the importance of developing flexible problem-solving strategies and higher-order reasoning for addressing challenging mathematical tasks (Khalid et al., 2020; Szabo et al., 2020). More recent developments concerning Olympiad-level mathematical reasoning further demonstrate the substantial reasoning demands associated with advanced competition problems (Hubert et al., 2026). These studies collectively indicate that successful performance on challenging mathematics problems cannot be explained solely by students' computational proficiency. Students may understand particular mathematical concepts but still encounter difficulties in interpreting problem requirements, translating contextual information into mathematical forms, executing appropriate procedures, or communicating their final solutions Therefore, examining the specific points at which students' solution processes break down is essential for obtaining a more informative account of their mathematical difficulties Such diagnostic evidence is particularly relevant to KSM preparation because identifying students' errors can provide a foundation for designing learning and coaching strategies that address specific weaknesses rather than merely increasing the quantity of competition practice.

One systematic approach for diagnosing such difficulties is Newman Error Analysis (NEA), which differentiates errors according to the stages through which students progress when solving mathematical problems NEA categorizes difficulties into reading, comprehension, transformation, process skills, and encoding, thereby allowing errors to be examined as different forms of breakdown within the problem-solving process rather than simply as incorrect final answers Recent studies have demonstrated the usefulness of Newman-based analysis for identifying students' difficulties in mathematical word problems and other problem-solving contexts (Ahzan et al., 2022; Mubarokah & Amir, 2024). At the same time, research on non-routine mathematical problems has largely

concentrated on students' strategies, skills, creativity, mathematization, and other cognitive characteristics associated with successful problem solving (Ergen, 2021; Kholid et al., 2024). Studies addressing mathematically demanding or competition-oriented environments have similarly placed greater emphasis on problem-solving strategies and advanced reasoning than on systematically tracing errors through the complete Newman sequence (Hubert et al., 2026; Szabo et al., 2020). Within the madrasah context, research has also examined differences in mathematics achievement between madrasah and non-madrasah students, illustrating continuing scholarly concern with mathematics learning in this distinctive educational setting (Umar et al., 2022). Nevertheless, these strands of research remain relatively disconnected because studies of non-routine problem solving, competition mathematics, madrasah education, and Newman-based error diagnosis have generally developed from different analytical perspectives. In particular, limited evidence is available concerning how reading, comprehension, transformation, process-skill, and encoding errors manifest when MTs students solve competition-oriented mathematics problems incorporating the characteristics of KSM. Moreover, students' previous competition experiences, preparation patterns, and regular study habits may provide valuable contextual information for interpreting the difficulties identified through their written solutions, although such information should not be interpreted as establishing causal relationships with particular error categories. Investigating these dimensions within a unified framework can therefore extend existing Newman-based research by providing a more context-sensitive diagnosis of mathematical problem solving within madrasah competition settings.

Despite growing scholarly attention to mathematical problem solving, several gaps remain in understanding students' errors when dealing with competition-oriented mathematics problems. Previous studies have predominantly investigated students' strategies, difficulties, creative thinking, mathematization, and cognitive characteristics in solving non-routine mathematical problems (Ergen, 2021; García-Moya et al., 2024; Kholid et al., 2024), while other research has emphasized the development of mathematical problem-solving strategies and higher-level reasoning required in challenging or competition settings (Hubert et al., 2026; Khalid et al., 2020; Szabo et al., 2020). Newman Error Analysis has also been employed to diagnose students' difficulties in mathematical problem solving, including errors encountered in mathematical literacy tasks (Mubarokah & Amir, 2024). However, these research strands largely remain separated, particularly in the context of madrasah education, where previous work has more commonly examined mathematics achievement and disparities between madrasah and non-madrasah students (Umar et al., 2022). Consequently, limited attention has been devoted to systematically examining how reading, comprehension, transformation, process-skill, and encoding errors emerge when MTs students engage with competition-oriented mathematics problems situated within the distinctive context of the Madrasah Science Competition (KSM). Addressing this gap, the present study integrates Newman Error Analysis with the context of competitive mathematical problem solving in madrasah education to provide a more detailed diagnosis of the stages at which students encounter difficulties and to generate evidence for developing more targeted problem-solving instruction and competition preparation.

Against this background, the present study aims to explore MTs students' errors in mathematical problem solving through Newman Error Analysis when they engage with Madrasah Science Competition mathematics problems. The investigation focuses on the five NEA categories of reading, comprehension, transformation, process skills, and encoding to determine the stages at which students experience difficulties during the solution process. Particular attention is given to KSM-style problems involving algebra, statistics, and probability, which constitute the mathematical domains examined in the study. Rather than evaluating students' performance solely from the correctness of their final answers, the analysis seeks to reveal how difficulties develop across

successive stages of mathematical problem solving. The study additionally examines students' previous KSM participation, competition preparation patterns, and regular mathematics study habits to provide contextual information for interpreting the observed errors. These characteristics are treated as complementary descriptive evidence rather than as variables intended to demonstrate causal effects on students' error patterns. Through this approach, the study seeks to bridge Newman-based error diagnosis with research on non-routine and competition-oriented mathematical problem solving in the distinctive context of madrasah education. The findings are expected to provide teachers with more precise information regarding the stages of problem solving that require greater instructional attention and sustained practice. Such evidence may also inform the development of KSM preparation activities that strengthen students' ability to interpret information, construct mathematical representations, execute solution procedures, and communicate final answers accurately. Ultimately, this study contributes to mathematics education research by providing a systematic account of students' problem-solving errors within a competition-oriented Islamic educational context and by offering an empirical basis for more targeted mathematics instruction in madrasahs.

## LITERATURE REVIEW

Mathematical problem solving represents a multidimensional process in which students coordinate conceptual knowledge, reasoning, procedural competence, and communication to construct appropriate solutions In educational contexts, successful problem solving requires students not only to obtain numerically correct answers but also to understand the information provided, recognize mathematical relationships, and determine suitable solution strategies (Kikas et al., 2020; Nilimaa, 2023; Olivares et al., 2021; Pambudi et al., 2020; Torres-Peña et al., 2025) Students may experience difficulty when a problem requires them to integrate several concepts or interpret information presented in unfamiliar forms Such difficulties become particularly visible in non-routine problems, where previously learned algorithms cannot always be applied directly Research on mathematical problem solving has consequently examined students' strategies, reasoning processes, and difficulties when dealing with problems requiring flexible approaches (Cox & Root, 2020; Elhilal, 2025; Gavaz et al., 2021; Jiang et al., 2021). Studies have also connected successful non-routine problem solving with mathematization, creativity, and the ability to reorganize mathematical knowledge according to the demands of a particular problem (García-Moya et al., 2024; Kholid et al., 2024). These findings indicate that students' performance should be understood through the processes underlying their solutions rather than solely through the correctness of their final responses. An incorrect answer, for example, may result from misunderstanding the problem, selecting an inappropriate strategy, making a procedural error, or inaccurately communicating an otherwise appropriate solution Distinguishing among these possibilities is pedagogically important because different forms of difficulty require different forms of instructional support Therefore, analyzing the stages at which errors emerge provides an important foundation for understanding students' mathematical problem-solving performance.

The cognitive demands of mathematical problem solving become more pronounced when students engage with competition-oriented tasks Mathematics competition problems commonly emphasize reasoning, strategic flexibility, and the ability to connect mathematical concepts beyond routine classroom procedures Research concerning challenging mathematical tasks has highlighted the importance of flexible strategies and higher-order reasoning in supporting successful problem solving (Khalid et al., 2020; Szabo et al., 2020). More recent research on advanced and Olympiad-level mathematical reasoning has further demonstrated the complexity of reasoning required when

solving demanding competition problems (Hubert et al., 2026). Within the Indonesian madrasah context, the Madrasah Science Competition provides a distinctive setting because mathematics problems may combine disciplinary knowledge with situations reflecting Islamic educational contexts (Riwanda et al., 2026) Such problems can require students to interpret contextual information before determining the mathematical relationships and procedures necessary for reaching a solution The mathematical domains represented in the present study include algebra, statistics, and probability, with individual problems incorporating contexts such as tajwid, prophets, Qur'anic verses, and Eid al-Adha practices. Consequently, difficulties in solving these tasks may emerge from both mathematical processing and the interpretation of information embedded within the problem context Examining KSM problems from a problem-solving perspective therefore provides an opportunity to investigate how students manage multiple cognitive demands within a competition environment. A systematic diagnostic framework is consequently required to determine more precisely where students encounter difficulties during this process.

Newman Error Analysis provides such a diagnostic framework by conceptualizing mathematical problem solving as a sequence of stages in which different forms of error may occur In the framework applied in this study, students' errors are classified into five categories: reading, comprehension, transformation, process skills, and encoding A reading error occurs when a student incorrectly recognizes or interprets relevant symbols or keywords contained in a problem, whereas a comprehension error reflects difficulty in understanding the information provided or identifying what the problem requires. A transformation error occurs when students cannot appropriately convert the information in a word problem into a mathematical model or determine the operations and procedures needed to solve it. Process-skill errors arise when students have identified a potentially appropriate procedure but cannot execute the required calculations correctly. Encoding errors, meanwhile, concern difficulties in stating or recording an appropriate final answer after students have progressed through the preceding solution processes. These categories make NEA particularly useful because the framework distinguishes errors associated with understanding a problem from those related to mathematical representation, procedural execution, and communication Previous studies have employed Newman-based frameworks to investigate errors across different mathematical topics and educational levels (Ahzan et al., 2022; Mubarokah & Amir, 2024). The framework can therefore provide a more differentiated account of students' difficulties than an assessment based solely on correct and incorrect responses Applying the complete sequence to KSM mathematics problems enables the present study to trace where students' mathematical problem-solving processes are most frequently disrupted.

Previous Newman-based research demonstrates that mathematical errors may arise at multiple stages and that their characteristics can differ according to the mathematical task and learner context Research involving junior high school students has identified Newman categories as a useful means of detecting errors when students solve mathematics problems (Ahzan et al., 2022). Similar investigations of mathematical word problems have shown that difficulties can involve interpreting information, selecting appropriate mathematical procedures, conducting calculations, and expressing final responses (Braithwaite & Sprague, 2021; Cook et al., 2020; Copur-Gencturk & Doleck, 2021; Cox & Root, 2020; Duffy et al., 2020). Newman-based analysis has also been extended to mathematical literacy tasks, illustrating its relevance to problems requiring students to connect mathematical understanding with contextual information (Mubarokah & Amir, 2024). These studies reinforce the importance of examining the process that produces an incorrect response rather than treating all errors as conceptually equivalent. Nevertheless, much of the Newman literature represented in the current study concerns conventional word problems, mathematical literacy tasks, or mathematics learning within regular classroom settings. Research on non-routine problem solving, meanwhile, has more frequently focused on strategies, creativity, mathematization, and

cognitive performance rather than on mapping errors systematically through all five Newman categories (Ergen, 2021; García-Moya et al., 2024; Kholid et al., 2024). Competition-oriented mathematics research has likewise tended to emphasize advanced reasoning and problem-solving performance rather than stage-specific diagnostic errors (Hubert et al., 2026; Szabo et al., 2020). This separation suggests that knowledge about how Newman error categories operate within competition-oriented mathematical problem solving remains comparatively limited. Extending NEA to KSM problems can therefore connect two relevant research traditions: diagnostic error analysis and the study of cognitively demanding non-routine mathematical problem solving.

The application of Newman Error Analysis within madrasah education is particularly relevant because mathematical learning occurs within an educational environment where academic and Islamic contexts may intersect Previous scholarship has emphasized that mathematics education in madrasahs can integrate disciplinary learning with Islamic values and contexts (Imamuddin et al., 2020; Nasution et al., 2023). Research has also examined mathematics achievement within madrasah settings, including differences between students educated in madrasah and non-madrasah environments (Umar et al., 2022). However, achievement-level comparisons do not necessarily reveal the specific stages at which students encounter difficulties when solving mathematically demanding tasks. In KSM, this issue is particularly relevant because students must coordinate their understanding of contextual information with the mathematical reasoning necessary to solve competition problems Students' previous exposure to competition problems, preparation patterns, and regular mathematics study habits may additionally provide contextual information for interpreting their approaches to such tasks These characteristics should nevertheless be distinguished from causal determinants because descriptive evidence concerning students' learning experiences does not independently establish that particular habits produce particular Newman errors. Integrating this contextual information with NEA can instead provide a richer interpretation of how students engage with KSM mathematics problems. Such an approach positions errors not merely as indicators of failure but as diagnostic evidence that can reveal where mathematical problem-solving processes require instructional reinforcement Accordingly, examining MTs students through the complete Newman sequence offers a theoretically grounded basis for identifying difficulties in reading, comprehension, mathematical transformation, procedural execution, and final-answer communication.

## METHOD

### *Research Design*

This study employed a qualitative approach with a case study design to explore MTs students' errors in solving mathematics problems modeled on the Madrasah Science Competition (KSM). The qualitative approach enabled the investigation to focus on the processes underlying students' mathematical errors rather than solely on the correctness of their final answers. Newman Error Analysis (NEA) served as the primary analytical framework for identifying difficulties occurring at different stages of mathematical problem solving. The analysis covered five error categories: reading, comprehension, transformation, process skills, and encoding. In addition to identifying these errors, the study examined contextual information concerning students' previous participation in KSM, competition preparation, and regular mathematics study habits. These data were used to provide additional context for interpreting students' problem-solving experiences rather than to establish causal relationships between learning characteristics and specific error categories. The case study design was considered appropriate because the investigation focused on students' responses within the specific setting of competition-oriented mathematics problems in madrasah education. The mathematical tasks incorporated contexts characteristic of KSM while representing several

mathematical domains. Students' written solutions were examined systematically to determine the stages at which difficulties occurred. Accordingly, the research design integrated qualitative error diagnosis with contextual information about students' experiences in learning and preparing for KSM.

### *Participant*

The participants were MTs students in Sleman Regency, Indonesia, including students with and without previous experience participating in the Madrasah Science Competition. This variation provided different competition backgrounds within the cases examined in the study. All participants completed the same set of KSM-style mathematics problems used to identify their mathematical problem-solving errors. Students also provided information concerning their previous KSM participation, preparation patterns, and regular mathematics study habits. Their previous participation was categorized according to whether they had participated in KSM before the study. Information about competition preparation included the frequency and duration of students' preparation activities. Regular mathematics study habits were examined through students' reported study schedules and duration. These characteristics were treated as contextual information supporting interpretation of the identified error patterns. The primary unit of analysis remained students' responses to the KSM-style mathematics problems. Further demographic and participant-selection information should be reported in the final manuscript if available to strengthen the transparency and transferability of the case study.

### *Instrument and Data Collection*

Data were collected using a mathematics problem-solving test modeled on KSM problems and a questionnaire addressing students' KSM experiences, preparation, and mathematics study habits. The problem-solving test served as the principal source for identifying errors occurring during students' solution processes. Error identification was guided by the five categories of Newman Error Analysis. The analytical prompts were informed by the Newman procedure described by White (1999), which examines students' reading, comprehension, transformation, process skills, and encoding during problem solving. The operational indicators were further adapted from Fitriatien (2019) and Sutama and Indriyani (2021). The resulting indicators provided consistent criteria for examining students' responses and distinguishing among different forms of mathematical error. The operational definitions applied in the analysis are presented in Table 1.

**Table 1.** Indicator NEA

| ***Error Type*** | **Indicator** |
|---|---|
| *Reading (R)* | Misreading symbols or keywords written in the question. |
| *Comprehension (C)* | The inability to comprehend the meaning of a problem refers to errors in recording the information provided in the problem, or an inability to explain what is known and what is being asked. |
| *Transformation(T)* | Errors in converting word problems into mathematical models. In other words, students are unable to plan and identify the operations and procedures required to solve the problems. |
| *Process skills (P)* | Errors in calculation procedures. In this instance, the student is able to plan and identify the operations and procedures for solving the problem but fails to execute the calculation procedures accurately. |
| *Encoding (E)* | Error in writing the final answer. The student had found the final solution but made a mistake in stating the final answer or the correct answer. |

The mathematics test consisted of five KSM-style problems representing algebra, statistics, and probability, consistent with the content examined in the original study. The problems incorporated Islamic contexts characteristic of KSM, including tajwid in Surah Al-Insyirah, the names of prophets, Qur'anic verses, and Eid al-Adha practices. Three questions addressed algebra, one addressed statistics, and one addressed probability. The distribution of the five questions and their corresponding mathematical subtopics is presented in Table 2.

**Table 2.** Questions and their mathematics sub topics

| Question (Q) | Mathematics sub topic |
|---|---|
| **Q1:** The mode of the tajweed appears in Surah Al-Insyirah is...<br>A. Ghunnah<br>B. Mad Thabi'I<br>C. Qalqalah<br>D. Ikhfa Haqiqi | Statistics |
| **Q2:** Determine the value of $(x + y)$ if<br>$1234x - 234y = 9999$<br>$-234x + 1234y = 1$ | Algebra |
| **Q3:** In a box, there are cards with the names of 25 prophets written on them that must be known. The probability of drawing two cards, both of which have the names of prophets who are related by father and son, is... | Probability |
| **Q4:** The function $g$ is defined by $g\left(\frac{1-x}{x}\right) = \frac{1}{x+1}$.<br>If $g(p)$ is a function $g$ with the $p$ variable, then the value of function $g(p)$ if<br>$p$ is the ordered number of the below verse is ….<br>وَتَكُونُ الْجِبَالُ كَالْعِهْنِ الْمَنفُوشِ | Algebra |
| **Q5:** During Eid al-Adha, the Al-Ikhwah Mosque slaughtered 4 cows, 3 goats, and 2 sheep for Rp. 103,900,000. The Al-Ikhlas Mosque slaughtered 3 cows, 7 goats, and 3 sheep for Rp. 92,800,000. The Al-Fatah Mosque slaughtered 5 cows, 6 goats, and 4 sheep for Rp. 138,500,000. It is assumed that the price of each cow in the three mosques is the same, as is the price of each goat and sheep. The minimum contribution per person for the cow donation is … rupiah. | Algebra |

The questionnaire complemented the test by collecting information regarding students' previous KSM participation, preparation schedules, preparation duration, and regular mathematics study patterns. Test and questionnaire data were subsequently considered together to provide a contextualized account of students' mathematical problem-solving difficulties.

***Research Procedure***

The study was conducted through a sequential procedure beginning with the preparation of the KSM-style mathematics test and the establishment of the NEA analytical indicators. First, five mathematics problems representing algebra, statistics, and probability were prepared within contexts characteristic of the Madrasah Science Competition. Second, the error-analysis criteria were established according to the five NEA categories presented in Table 1. Third, the mathematics problem-solving test was administered to participating MTs students in Sleman Regency. Fourth, students completed the questionnaire concerning previous KSM participation, competition preparation, and regular mathematics study habits. Fifth, the collected responses were reviewed and

organized during the data-reduction stage. Sixth, each student's solution to the five problems presented in Table 2 was examined and categorized according to the relevant Newman error indicators. Seventh, the occurrence of each error category was summarized across the problems to identify the most and least frequent difficulties. Eighth, questionnaire responses were organized descriptively to characterize students' competition experience, preparation patterns, and mathematics study habits. Ninth, the error-analysis results and contextual questionnaire information were interpreted together to develop a comprehensive account of students' problem-solving difficulties. Finally, conclusions were drawn regarding the stages at which MTs students encountered difficulties when solving KSM-style mathematics problems and the implications of these patterns for mathematics instruction and competition preparation.

### *Data Analysis*

Data were analyzed using the Miles and Huberman framework, consisting of data reduction, data display, and conclusion drawing. During data reduction, students' written responses and questionnaire data were reviewed, organized, and assessed for their relevance and readability. The mathematical solutions were then examined question by question using the five NEA categories presented in Table 1. A reading error was coded when students incorrectly interpreted relevant symbols or keywords, while a comprehension error was identified when students could not appropriately understand or state the information given and what was required by the problem. Transformation errors were identified when students failed to convert the information into an appropriate mathematical model, operation, or solution strategy. Process-skill errors occurred when an appropriate procedure had been identified but was executed incorrectly, whereas encoding errors were identified when students failed to state the final answer appropriately. These definitions correspond to the operational indicators employed in the original analysis. The occurrence of each error category was summarized across the five KSM-style problems to identify the dominant patterns of students' difficulties. Questionnaire responses were analyzed descriptively to characterize students' KSM participation, competition preparation, and regular mathematics study habits. These contextual data were not analyzed as causal predictors of Newman error categories but were used to enrich the interpretation of students' mathematical problem-solving experiences. Conclusions were subsequently drawn by integrating the NEA error patterns with the contextual evidence obtained from the questionnaire.

## RESULTS AND DISCUSSION

### *Results*

#### Analysis of Student Errors in Solving KSM-Type Problems

Based on the students' responses, the percentage of errors made by the students, according to Newmann's error analysis, is presented in Table 3.

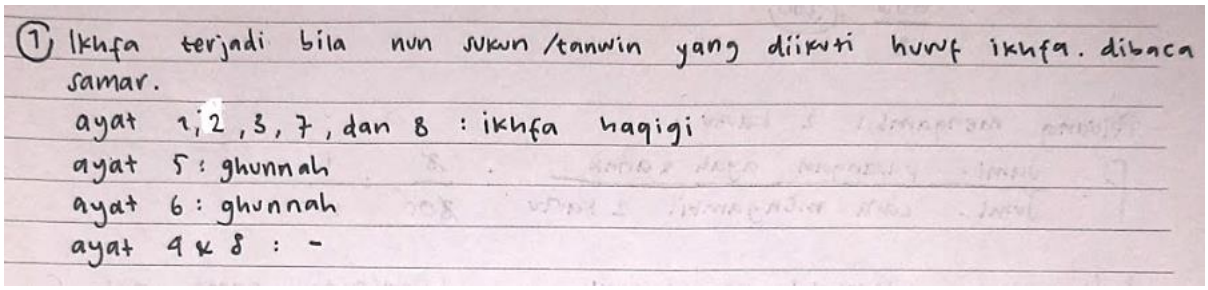
**Table 3.** Student Error Percentage

| Question (Q) | Reading (R) (%) | Comprehension (C) (%) | Transformation (T) (%) | Process skills (P) (%) | Encoding (E) (%) |
|---|---|---|---|---|---|
| 1 | 42 | 50 | 58 | 58 | 67 |
| 2 | 33 | 33 | 100 | 100 | 100 |
| 3 | 50 | 75 | 83 | 83 | 100 |
| 4 | 25 | 67 | 83 | 100 | 100 |
| 5 | 33 | 42 | 75 | 83 | 100 |
| **Average** | **37** | **53** | **80** | **85** | **93** |

Based on Table 2, the most frequent error made by students was in encoding (93%), followed by process skills (85%) and transformation (80%). Conversely, the least frequent error was in reading (37%). The details of each error type are described below.

***Reading Error***

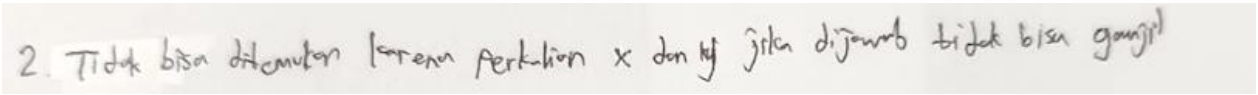
A reading error occurs when a student misreads a symbol or keyword, or even fails to recognize a keyword in the problem. The reading errors made by students in answering Question 1 (Q1) are shown in Figure 1 below.




*Translated:*
*Ikhfa occurs when the nun sukun/tanwin followed by the letter ikhfa is read indistinctly/ samar*
*Verse 1,2,3,7,and 8: ikhfa haqiqi*
*Verse 5: ghunnah*
*Verse 6: ghunnah*
*Verse 4 & 8: -*

**Figure 1.** Reading Error 1

Figure 1 does not demonstrate that the students understand the meaning of mode or *tajwid*. Of all the types of *tajwid* mentioned in the question, the students provided only a single definition, and even that definition was incorrect. The failure to demonstrate knowledge regarding the concepts asked about specifically mode indicates that the students struggle to grasp the meaning of the term, making it very difficult for them to proceed with answering the question. (Lubis et al., 2021). The students' work on question Q2 in Figure 2 shows that the students misread the question. The question asks for the value of $(x + y)$ namely those related to addition, whereas students answered those related to $xy$ ($x$ times $y$).




*Translated: Cannot be found because the multiplication of x and y cannot be odd if answered*

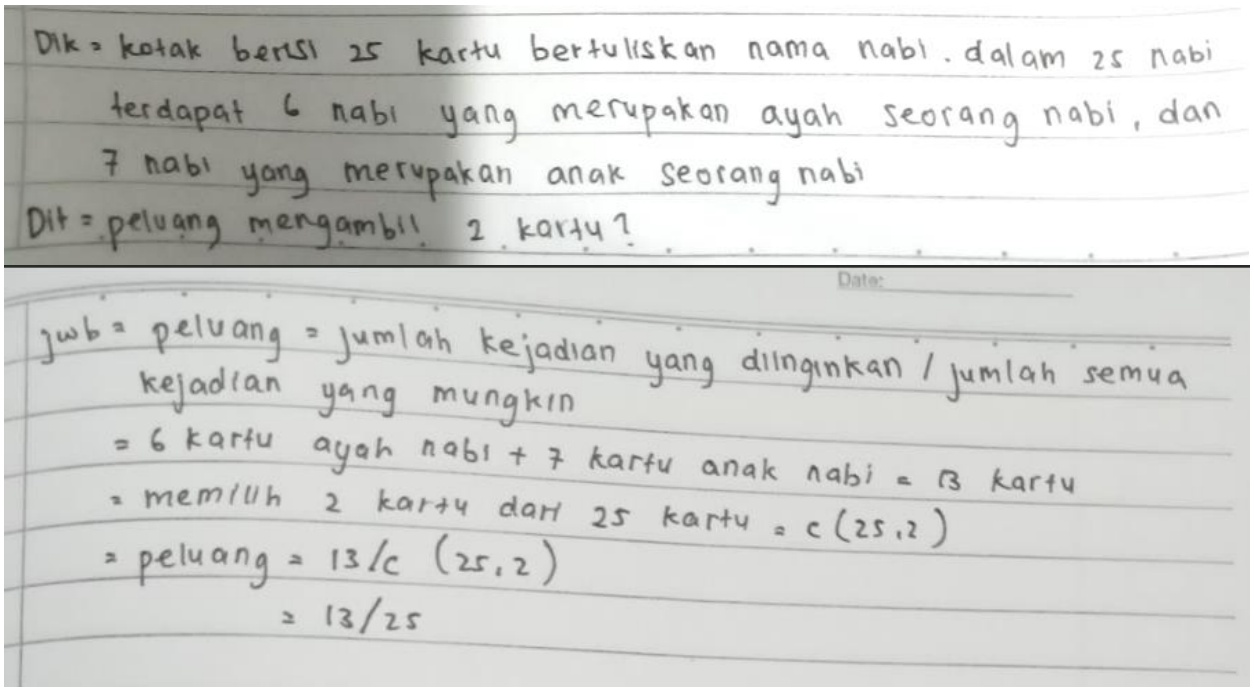
**Figure 2.** Reading Error 2

(Wiranti et al., 2023) state in their study that reading errors occur among students who read hastily or skim the text, failing to pay attention to the symbols or words present in the material. In the present study, it is possible that students committed reading errors because they read too quickly, thereby overlooking important information contained in the questions.

***Comprehension Error***

The comprehension error made by the student is illustrated in Figure 3. In their response to question Q3, the student did not accurately state the information provided in the problem. Although the student attempted to answer by noting the number of prophets who were fathers to other prophets and the number who were sons of other prophets, they failed to fully articulate what the question was asking. Consequently, it appears the student did not grasp the given information or the specific question asked, indicating a comprehension error. Furthermore, the student provided a

general probability formula rather than addressing the specific requirement of the question. The question specifically asked "The probability of drawing two cards, both of which have the names of prophets who are related by father and son".




Translated:
*Known:*
*box containing 25 cards with the name of the prophet in 25 prophets. there are 6 prophets who are the father of a prophet and 7 prophets who are the sons of a prophet*
*Asked: probability of taking 2 cards*

*Answer:*
*Probability=sum of event wanted/sum of all possible event*
*= 6 cards of prophet's father+7 cards of prophet's son=13 cards*
*= choosing 2 cards from 25 cards=C(25,2)*
*=probability=13/C(25,2)=13/25*

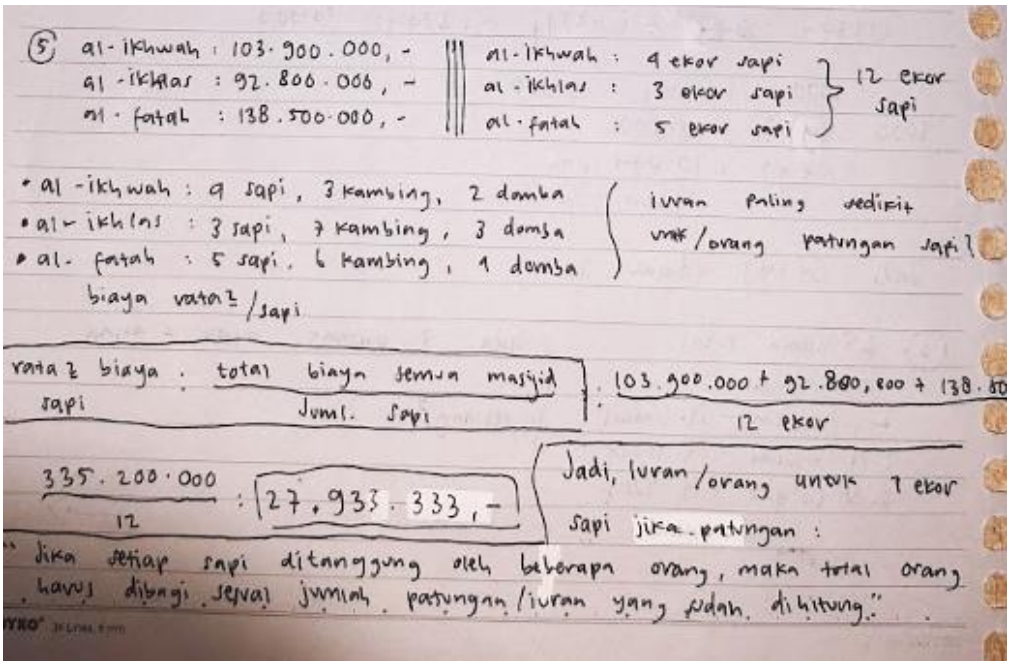
**Figure 3.** Comprehension Error

Students demonstrate a basic understanding of probability when working on problems; however, they find the resolution of more complex probability problems confusing, often leaving them unable to complete the task. This issue may stem from a tendency to view probability solely as the ratio of favorable outcomes to the total number of possible outcomes. Students often fixate on this single definition, disregarding other aspects even when the problem specifically addresses them. Beyond errors in noting down the given information and the question itself, comprehension errors can also occur when students correctly identify the knowns and the question but fail to accurately interpret the information provided in the problem (Wiranti et al., 2023).

***Transformation Error***

The "Transformation Error" shown in Figure 4 indicates that the student was unable to construct a mathematical model based on the provided word problem. The student even disregarded the goats and sheep included in the total cost paid for the sacrificial animals. The student only took the number of cows into account because the problem asked for the cost per person to offer a cow

for sacrifice. The student performed a calculation they termed the "average cost of a cow" by dividing the total expenditure across all mosques by the number of cows. Furthermore, the student failed to apply the knowledge that a single cow can be offered as a sacrifice by up to seven people.




*Translated:*

*Al-ikhwah: 103.900.000,- ||al-ikhwah: 4 cows*
*Al-ikhlas: 92.800.000,- || al ikhlas: 3 cows*
*Al-fatah: 138.500.000,- || al-fatah: 5 cows*
} *12 cows*

*Al-ikhwah: 4 cows, 3 goats, 2 sheep*
*Al-ikhlas: 3 cows, 7 goats, 3 sheep*
*Al-fatah: 5 cows, 6 goats, 4 sheep*
} *What is the minimum contribution for each person to contribute to the cow donation?*

*Average cost of the cow=total cost of all of mosque/amount of cows*
*=103.900+92.800.000+138.500.000/12 cows*
*=335.200.000/12*
*=27.933.333,-*

*So, donation per person = If each cow is borne by several people, the total number of people must be divided by the joint venture/contribution amount that has been calculated*

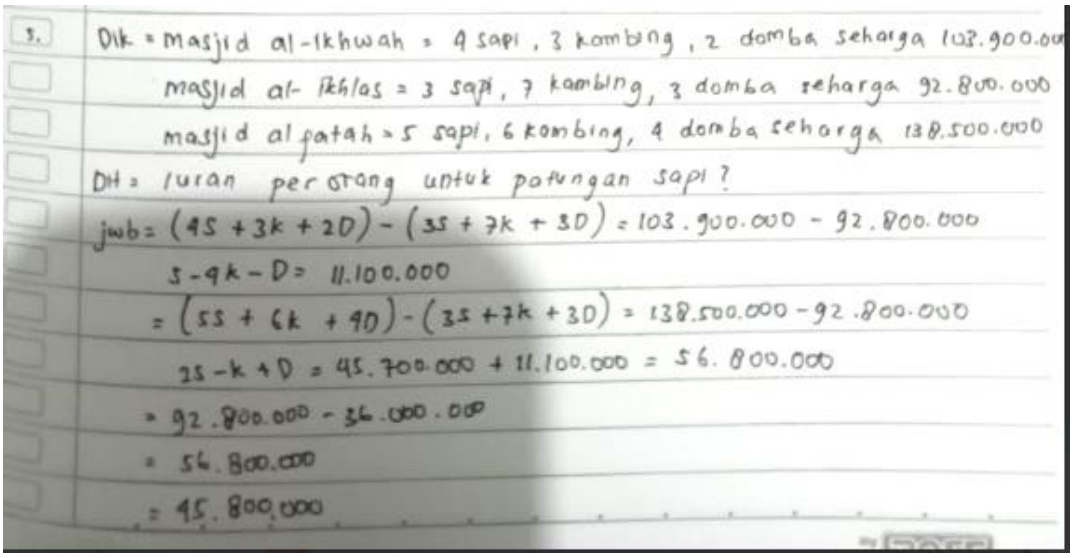
**Figure 4.** Transformation Error

Students' failure to transform word problems into mathematical models stems from a lack of care when writing down the mathematical operations or procedures presented in the problems. (Prasetyaningrum et al., 2022). This error can also occur when students incorrectly select and use a formula (Wiranti et al., 2023).

***Process skills Error***

A "process skills error" refers to a mistake made by a student while executing a calculation procedure. Although the student is able to identify the procedure required to solve the problem, they fail to carry it out correctly. Figure 5 shows that the student has written down the mathematical model for the given word problem and attempted to execute the solution procedure. However, the student made an operational error, resulting in the problem remaining unsolved. In this instance, the

student employed the elimination method but was unable to complete the process, thereby failing to obtain a solution to the problem. The student performed elimination on the first and second equations, followed by elimination on the second and third equations.




*Translated*
*Known:*
*Al-ikhwah mosque= 4 cows, 3 goats, 2 sheep total 103.900.000*
*Al-ikhlas mosque= 3 cows, 7 goats, 3 sheep total 92.800.000*
*Al-fatah mosque= 5 cows, 6 goats, 4 sheep total 138.500.000*

*Asked:*
*Each person contribution for cow donation?*

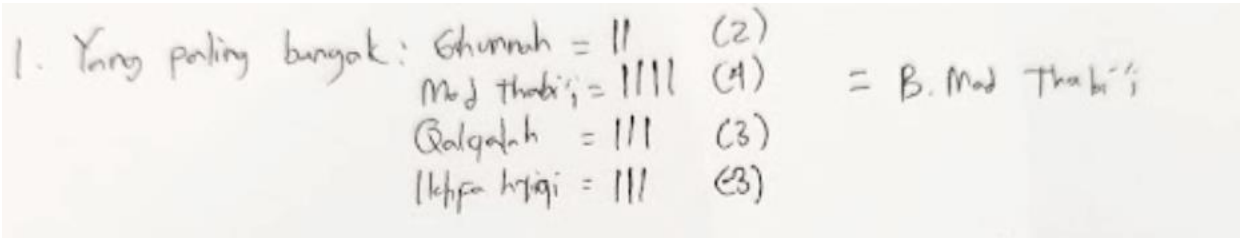
*Answer:*
*S=number of cow*
*K=number of goats*
*D=number of sheep*
*(4S+3K+2D)-(3S+7K+3D)=103.900.000-92.800.000*
*S-4K-D=11.100.000*
*=(5S+6K+4D)-(3S+7K+3D)=138.500.000-92.800.000*
*2S-K+D=45.700.000+11.100.000=56.800.000*
*=92.800.000-36.000.000*
*=56.800.000*
*=45.800.000*

**Figure 5.** Process Skill Error

The students' inability to perform the operations required to solve this problem, even though they already knew which operations to use aligns with (Murtiyasa & Wulandari, 2020) view. Furthermore, the study by (Wiranti et al., 2023) suggests that this error may occur because students lack a grasp of basic mathematical concepts.

***Encoding Error***

The encoding errors made by the students can be seen in Figure 6 below.




Translated
1. the most: Ghunnah = || (2)
Mad tabi'i = |||| (4)
Qalqalah = ||| (3)
Ikhfa haqiqi = ||| (3)
=B. Mad tabi'i sapi

**Figure 6.** Encoding Error

Figure 6 shows the student using tally marks to identify each occurrence of the specific *tajwid* rule within the recitation of Surah Al-Insyirah; the total count is recorded in parentheses next to the tallies. Although the student wrote "=B. Mad tabi'i" on the right side, they failed to explicitly state that this represented the mode or the specific value requested by the question—which constituted the correct answer. In this instance, the student arrived at the final solution but did not explicitly designate the correct answer on the answer sheet. This aligns with the findings of (Wiranti et al., 2023), who noted that such errors occur when students fail to record a final answer that corresponds to what the question asks. Encoding errors typically arise when students rush to complete a problem (Prasetyaningrum et al., 2022) or are unaccustomed to writing down a final answer after solving the problem. (Sukoriyanto, 2020) considers encoding errors to be unfortunate for the student, given that they had essentially already determined the correct answer.

***Analysis of Students' Participation Experience in KSM, as well as Study Habits and Preparation for KSM.***

Information regarding the students' experience with KSM revealed that the majority of those involved in the study had never participated in the competition before. Approximately 25% of the students had prior experience, specifically at the regency level. As the participating students intended to take part in the next KSM cycle, they were asked to describe their study preparations. A quarter of the students (25%) did not provide details on their preparation methods. Another 25% stated that they prepared by practicing KSM questions three times a week for the month leading up to the event. The remaining students reported various study schedules: daily for one week prior, daily for two weeks prior, once a week starting one month prior, and once a week starting eleven months prior. All students consistently reported that each study session lasted between one and two hours.

In addition to providing information regarding their preparation for the KSM, students also shared details about their regular mathematics study habits. Approximately 42% of the students stated that they study mathematics only when there is homework or an upcoming exam. Meanwhile, 33% reported studying mathematics daily, and the remaining students indicated that their study habits depend on their mood or inclination. Based on this information, the errors students make when solving KSM-style problems might be influenced by their prior experience with such problems and their general mathematics study habits. The findings suggest that students still lack proficiency in tackling KSM-style problems and do not dedicate sufficient study time to deepening their mathematical skills. Furthermore, previous studies such as (Afini, 2023; Hasim et al., 2022; Yuliany et al., 2022) highlighted that study habits impacted the mathematics achievement. As motivation to achieve success also determines mathematics performance (Siregar et al., 2024), as do study habits,

therefore, building routine mathematics learning habit and maintaining motivation to become a KSM champion can help students achieve success in this championship.

**Discussion**

The findings demonstrate that MTs students experienced difficulties across all five stages of Newman Error Analysis when solving KSM-style mathematics problems, although the frequency of these errors varied substantially across categories. Encoding errors were the most prevalent, with an average occurrence of 93%, followed by process-skill errors at 85%, transformation errors at 80%, comprehension errors at 53%, and reading errors at 37%. This pattern indicates that students' difficulties became particularly pronounced during the later stages of mathematical problem solving, when they were required to execute procedures and communicate the outcomes of their reasoning. The predominance of encoding errors is consistent with Wiranti et al. (2023), who reported that students may fail to provide a final response that corresponds appropriately to the requirement of a problem even after engaging with the preceding solution processes. Prasetyaningrum et al. (2022) similarly associated encoding difficulties with students' tendency to rush through problem completion, whereas Sukoriyanto (2020) emphasized the significance of such errors because students may already have reached an essentially correct solution before failing to express it properly. In the present study, this phenomenon is clearly illustrated in Question 1, where a student correctly counted the occurrences of the tajwid categories but did not explicitly formulate the requested mode as the final response. Thus, the high encoding-error rate should not automatically be interpreted as evidence of an absence of mathematical knowledge, because in some cases the difficulty occurred in translating completed reasoning into an explicit and appropriate answer. At the same time, the presence of encoding errors across the KSM-style tasks suggests that communicating a mathematically complete answer constitutes an important component of competition-oriented problem solving This finding extends previous Newman-based research by demonstrating that the final communication stage remains a substantial source of difficulty even when mathematics is presented through KSM contexts that combine disciplinary content with Islamic situations. Consequently, instructional preparation for KSM should emphasize not only obtaining a solution but also verifying whether the final response precisely addresses the mathematical requirement posed by the problem

The second major finding concerns the high frequencies of process-skill and transformation errors, which reached 85% and 80%, respectively, indicating substantial difficulties in converting mathematical plans into accurate solution procedures. The transformation difficulty is particularly visible in Question 5, where a student considered only the number and total expenditure of cows while disregarding the contributions of goats and sheep to the total costs reported by the three mosques. This response demonstrates that recognizing individual quantities in a contextual problem does not necessarily ensure that students can organize those quantities into an appropriate mathematical model. Such a finding is consistent with Prasetyaningrum et al. (2022), who associated transformation errors with difficulties in translating word-problem information into suitable mathematical operations or procedures. It also corresponds with Wiranti et al. (2023), who identified inappropriate formula selection and use as potential manifestations of transformation errors. Process-skill difficulties emerged even when students demonstrated some awareness of the mathematical procedure required, as illustrated by the attempted elimination procedure in Question 5. The student successfully represented the numbers of cows, goats, and sheep and initiated elimination but subsequently committed operational errors that prevented the procedure from producing the required solution. This pattern supports Murtiyasa and Wulandari (2020), whose Newman-based analysis similarly identified difficulties in executing mathematical operations despite students' recognition of relevant procedures. Wiranti et al. (2023) further suggested that

weaknesses in basic mathematical concepts may contribute to process-skill errors, indicating that procedural inaccuracies can reflect deeper difficulties than isolated computational mistakes. Taken together, the high transformation and process-skill error rates indicate that KSM preparation should provide sustained opportunities for students to construct mathematical models from contextual information, justify the selection of procedures, and monitor the accuracy of calculations throughout the solution process

Although reading and comprehension errors occurred less frequently than transformation, process-skill, and encoding errors, they remain important because difficulties at these initial stages can constrain students' subsequent mathematical reasoning Reading errors averaged 37%, making them the least frequent category, while comprehension errors occurred in 53% of the analyzed responses. The reading-error examples reveal difficulties in attending accurately to mathematical terminology and symbols, including misunderstanding the statistical concept of mode in Question 1 and misreading the requested operation in Question 2. This observation is consistent with Wiranti et al. (2023), who reported that reading errors may emerge when students read hastily and consequently overlook important words or mathematical symbols. The comprehension error identified in the probability problem provides a different form of difficulty, because the student recorded some relevant information but interpreted the task primarily through a general probability formula rather than through the specific father–son relationship required by the question. Such a response indicates that identifying familiar mathematical vocabulary does not necessarily imply an adequate understanding of the relational structure embedded within a problem This finding is compatible with Wiranti et al. (2023), who observed that comprehension errors can persist even when students are able to identify some known and requested information but do not interpret that information accurately. The KSM context may make this distinction particularly important because the problems combine mathematical information with contextual elements such as tajwid, prophets, Qur'anic verses, and religious practices. Students must therefore distinguish contextual information that frames a task from quantitative and relational information that determines its mathematical structure The results consequently suggest that KSM-oriented instruction should explicitly develop careful reading and interpretation alongside mathematical modeling, rather than assuming that students who can read the problem text will necessarily understand its mathematical demand

A further contribution of the findings concerns the coexistence of multiple Newman error categories across the same set of competition-oriented problems, suggesting that students' difficulties should be interpreted as a sequence of potentially interconnected problem-solving challenges rather than as isolated mistakes Question 2, for example, produced 100% transformation, process-skill, and encoding errors, whereas Question 4 produced 100% process-skill and encoding errors, demonstrating that the distribution of difficulties varied according to the demands of individual tasks. This variation reinforces the diagnostic value of Newman Error Analysis because an overall score would not reveal whether an unsuccessful response originated in interpretation, mathematical representation, procedural execution, or final communication Ahzan et al. (2022) similarly employed NEA to detect errors among junior high school students, supporting the usefulness of stage-specific analysis for identifying barriers in mathematical problem solving. Prasetyaningrum et al. (2022) reported Newman categories in elementary students' word-problem solving, while Surya and Edriati (2024) applied Newman criteria to students at the upper-secondary madrasah level. The present findings extend this line of investigation by locating the analysis specifically within MTs students' engagement with KSM-style mathematics problems rather than conventional classroom exercises alone. This distinction is important because the five tasks examined algebra, statistics, and probability through mathematical and Islamic contextual information, thereby requiring students to coordinate contextual interpretation with disciplinary reasoning. The observed progression from relatively lower reading errors toward considerably

higher transformation, process-skill, and encoding errors indicates that recognizing problem information was generally less problematic than using that information to construct, execute, and communicate a complete solution. However, the percentages should not be interpreted as demonstrating that one Newman stage causally produces errors at a subsequent stage, because the study employed a qualitative case study design rather than a causal or sequential statistical model. Instead, the distribution provides diagnostic evidence that students require support across the complete problem-solving process, with particularly strong attention to mathematical representation, procedural accuracy, and answer formulation From this perspective, NEA offers pedagogical value not merely as a classification system but as a basis for identifying which stages of KSM-oriented problem solving warrant targeted instructional intervention

The questionnaire findings provide additional context for interpreting these error patterns, although they should be treated descriptively rather than as evidence that study habits or KSM experience caused particular errors. Most participating students had never previously participated in KSM, while approximately 25% reported prior competition experience at the regency level. Preparation patterns were also heterogeneous, ranging from daily preparation shortly before the competition to weekly preparation extending over several months, while the reported duration of individual study sessions was generally one to two hours. Regular mathematics study habits showed similar variation, with approximately 42% of students studying mathematics primarily when homework or examinations required it, 33% reporting daily study, and the remaining students describing mood-dependent patterns. These characteristics provide a plausible contextual explanation for why sustained familiarity with complex KSM-style problems may not yet have been established among all participants, but the present design does not permit this interpretation to be treated as a causal conclusion. Previous studies nevertheless provide relevant comparative evidence, as Afini (2023), Hasim et al. (2022), and Yuliany et al. (2022) reported relationships between study habits and mathematics achievement, while Siregar et al. (2024) examined achievement motivation and study habits in relation to mathematics learning outcomes. In relation to these studies, the present research adds a more specific perspective by considering learning habits and competition experience alongside the particular stages of error revealed through NEA rather than examining mathematics achievement only as an aggregate outcome. The findings therefore support the pedagogical value of sustained exposure to KSM-style tasks in which students practice interpreting contexts, constructing models, performing procedures, and explicitly checking their final answers Such preparation should incorporate Islamic contexts as meaningful components of the mathematical tasks while ensuring that contextual familiarity does not substitute for rigorous mathematical reasoning Overall, the combined evidence suggests that improving MTs students' readiness for KSM requires systematic attention to the entire problem-solving sequence, with instructional feedback directed toward the specific Newman stage at which each student's reasoning becomes incomplete or inaccurate

## Implications

The findings have important implications for improving mathematics instruction and KSM preparation at the MTs level. The predominance of encoding, process-skill, and transformation errors indicates that instruction should emphasize mathematical modeling, procedural accuracy, and clear communication of final answers. Newman Error Analysis can therefore be used as a diagnostic framework to identify the specific stages at which students experience difficulty. Teachers should provide structured practice with non-routine problems that requires students to interpret information, construct appropriate mathematical models, and justify their solution procedures. Students should also be encouraged to review their work and ensure that their final answers directly address the questions posed. The integration of Islamic contexts into KSM-style mathematics problems can provide meaningful learning experiences while maintaining a strong emphasis on mathematical reasoning. The variation in students' competition

experience and study patterns further indicates the importance of systematic and sustained KSM preparation. At the institutional level, madrasahs can use students' error profiles to design more targeted coaching and instructional support. Such support can be differentiated according to difficulties in comprehension, transformation, procedural execution, or answer formulation. However, these implications should be interpreted as pedagogical directions rather than causal conclusions because of the qualitative case study design. Overall, combining diagnostic error analysis with continuous problem-solving practice may strengthen students' readiness for competition-oriented mathematics tasks. This approach can also contribute to the broader development of mathematical problem-solving competence among MTs students.

**Limitations and Suggestions for Future Research**

This study has several limitations that should be considered when interpreting its findings. First, the investigation was limited to MTs students in Sleman Regency, restricting the transferability of the results to other madrasah contexts. Second, the analysis involved only five KSM-style problems covering algebra, statistics, and probability. Therefore, the identified Newman error patterns may not represent students' difficulties across all mathematical domains tested in competition settings. Third, the qualitative case study design does not permit causal conclusions regarding the relationships between KSM experience, preparation, study habits, and specific error categories. The questionnaire data may also be influenced by students' self-reported perceptions and recall. Future research should involve participants from multiple madrasahs and different geographical contexts. A broader range of mathematical topics and levels of problem complexity should also be investigated. Interviews or think-aloud protocols could provide deeper evidence regarding the reasoning underlying each Newman error. Longitudinal studies are recommended to examine changes in error patterns following sustained KSM preparation. Larger-scale quantitative or mixed-methods studies could further investigate relationships between students' learning characteristics and specific error categories. Comparative studies between students with different levels of KSM experience may also provide valuable insights. Overall, future research should broaden the contexts, participants, and methodological approaches used to understand MTs students' difficulties in competition-oriented mathematical problem solving.

## CONCLUSION

This study examines the errors students make when solving KSM-style mathematics problems categorized using the Newman Error Analysis (NEA) framework, while also analyzing their prior KSM participation experience, study habits, and preparation. The findings reveal that students committed the most errors regarding encoding and process skills, while errors related to reading skills were the least frequent. All error types identified by the NEA framework occurred, likely influenced by students' past KSM participation and their specific study habits and preparation. The results underscore the importance of a more systematic instructional approach, grounded in consistent, continuous practice, whether independent or guided to help students minimize errors and deepen their understanding of the mathematical concepts tested in the KSM. Consequently, *madrasah* institutions and educators need to adopt a more comprehensive approach to designing instructional strategies that are adaptive and tailored to student needs. Furthermore, students' independent study efforts are crucial in catalyzing the development of skills required for KSM-style problems. Integrating Islamic values into mathematics instruction should also be prioritized to foster a better understanding of the relationship between knowledge and faith. Through the application of appropriate problem-solving strategies and sustained coaching support, it is hoped that *madrasah* students will enhance their performance in competitions like the KSM and gain a deeper, more practical understanding of mathematics.

## AUTHOR CONTRIBUTIONS STATEMENT

Fina Hanifa Hidayati contributed to the conceptualization, research design, instrument development, data collection, data analysis, interpretation of findings, and preparation of the original manuscript. Iqbal Ramadani contributed to the methodological development, data analysis, interpretation of the results, and critical revision of the manuscript. Nidya Ferry Wulandari contributed to data validation, interpretation of the findings, manuscript review, and final editing for academic quality and coherence. All authors read and approved the final version of the manuscript.

## REFERENCES

Afini, A. (2023). Korelasi antara pola asuh dan kebiasaan belajar terhadap prestasi matematika siswa SMA di masa pandemi. *Jurnal Pendidikan Matematika Undiksha*, *14(1)*.. https://doi.org/10.23887/jjpm.v14i1.54267

Ahzan, Z. N., Simarmata, J. E., & Mone, F. (2022). Using Newman error analysis to detect students' error in solving junior high school mathematics problem. *Jurnal Pendidikan MIPA*, *23*(2), 459–473.

Braithwaite, D. W., & Sprague, L. (2021). Conceptual knowledge, procedural knowledge, and metacognition in routine and nonroutine problem solving. *Cognitive Science*, *45*(10), e13048. https://doi.org/10.1111/cogs.13048

Cook, S. C., Collins, L. W., Morin, L. L., & Riccomini, P. J. (2020). Schema-based instruction for mathematical word problem solving: An evidence-based review for students with learning disabilities. *Learning Disability Quarterly*, *43*(2), 75–87. https://doi.org/10.1177/0731948718823080

Copur-Gencturk, Y., & Doleck, T. (2021). Strategic competence for multistep fraction word problems: An overlooked aspect of mathematical knowledge for teaching. *Educational Studies in Mathematics*, *107*(1), 49–70. https://doi.org/10.1007/s10649–021–10028–1

Cox, S. K., & Root, J. R. (2020). Modified schema-based instruction to develop flexible mathematics problem-solving strategies for students with autism spectrum disorder. *Remedial and Special Education*, *41*(3), 139–151. https://doi.org/10.1177/0741932518792660

Dahirin, & Rusmin. (2024). Integrasi nilai-nilai keislaman pada peserta didik melalui pembelajaran pendidikan agama Islam. *Dirasah: Jurnal Studi Ilmu Dan Manajemen Pendidikan Islam*, *7*(2), 762–771. https://doi.org/10.58401/dirasah.v7i2.1325

Duffy, G., Sorby, S., & Bowe, B. (2020). An investigation of the role of spatial ability in representing and solving word problems among engineering students. *Journal of Engineering Education*, *109*(3), 424–442. https://doi.org/10.1002/jee.20349

Elhilal, A. (2025). Digital conceptual mapping for enhancing mathematical concept formation and creative mathematical problem-solving through cognitive flexibility skills: A mixed methods study. *Cogent Education*, *12*(1), 2494945. https://doi.org/10.1080/2331186X.2025.2494945

Ergen, Y. (2021). "Does mathematics fool us?: ' A study on fourth grade students" non-routine maths problem solving skills. *Issues in Educational Research*, *30*(3), 845–865. https://doi.org/10.3316/informit.465172146087415

Ferede, A. T., Ayele, M. A., Mihrka, A. A., & Arara, A. A. (2026). The impact of contextualized teaching and learning approach on students' conceptual understanding of trigonometry. *Teaching Mathematics and Its Applications: An International Journal of the IMA*, *45*(2), 161–180. https://doi.org/10.1093/teamat/hraf008

García-Moya, M., Marcos, S., & Fernández-Cézar, R. (2024). Non-routine mathematical problems and the strategies used by gifted students: A case study. *Journal of Research in Special Educational Needs*, *24*(4), 1175–1189. https://doi.org/10.1111/1471–3802.12695

Gavaz, H. O., Yazgan, Y., & Arslan, Ç. (2021). Non-routine problem solving and strategy flexibility: A quasi-experimental study. *Journal of Pedagogical Research*, *5*(3), 40–54. https://doi.org/10.33902/JPR.2021370581

Hasim, F., Baharullah, & Sukmawati. (2022). Pengaruh konsep diri dan kebiasaan belajar terhadap hasil belajar matematika siswa. *PEDAGOGIKA.*. https://doi.org/10.37411/pedagogika.v13i2.1468

Hubert, T., Mehta, R., Sartran, L., Horváth, M. Z., Žužić, G., Wieser, E., Huang, A., Schrittwieser, J., Schroecker, Y., Masoom, H., Bertolli, O., Zahavy, T., Mandhane, A., Yung, J., Beloshapka, I., Ibarz, B., Veeriah, V., Yu, L., Nash, O., … Silver, D. (2026). Olympiad-level formal mathematical reasoning with reinforcement learning. *Nature*, *651*(8106), 607–613. https://doi.org/10.1038/s41586-025-09833-y

Imamuddin, M., Isnaniah, I., Zulmuqim, Z., Nurdin, S., & Andryadi, A. (2020). Integrasi pendidikan matematika dan pendidikan Islam (Menggagas pembelajaran matematika di Madrasah Ibtidaiyah). *AR-RIAYAH: Jurnal Pendidikan Dasar*, *4*(2), 117–130. https://doi.org/10.29240/jpd.v4i2.1928

Jiang, R., Liu, R., Star, J., Zhen, R., Wang, J., Hong, W., Jiang, S., Sun, Y., & Fu, X. (2021). How mathematics anxiety affects students' inflexible perseverance in mathematics problem-solving: Examining the mediating role of cognitive reflection. *British Journal of Educational Psychology*, *91*(1), e12364. https://doi.org/10.1111/bjep.12364

Khalid, M., Saad, S., Hamid, S. R. A., Abdullah, M. R., Ibrahim, H., & Shahrill, M. (2020). Enhancing creativity and problem solving skills through creative problem solving in teaching mathematics. *Creativity Studies*, *13*(2), 270–291. https://doi.org/10.3846/cs.2020.11027

Kholid, M. N., Mahmudah, M. H., Ishartono, N., Putra, F. G., & Forthmann, B. (2024). Classification of students' creative thinking for non-routine mathematical problems. *Cogent Education*, *11*(1), 2394738. https://doi.org/10.1080/2331186X.2024.2394738

Kikas, E., Mädamürk, K., & Palu, A. (2020). What role do comprehension-oriented learning strategies have in solving math calculation and word problems at the end of middle school? British Journal of Educational Psychology, 90(S1), 105–123. https://doi.org/10.1111/bjep.12308

Kusnirova, D., Scholtzova, I., & Kresila, J. (2026). A systematic review into the approach of contextual teaching and learning in mathematics education. *European Journal of Science and Mathematics Education*, *14*(3), 379–394. https://doi.org/10.30935/scimath/18575

Lubis, R. S., Pramudya, I., & Subanti, S. (2021). Mathematics literacy: Newman's error analysis (NEA) review from habits of mind. *Proceedings of the International Conference of Mathematics and Mathematics Education (I-CMME 2021)*, *597.*. https://doi.org/10.2991/assehr.k.211122.033

Mubarokah, A. A. L., & Amir, M. F. (2024). Primary students' errors in solving mathematical literacy problems based on Newman analysis. *Jurnal Pendidikan Matematika*, *18*(2), 217–230. https://doi.org/10.22342/jpm.v18i2.pp217-230

Murtiyasa, B., & Wulandari, V. (2020). Analisis kesalahan siswa materi bilangan pecahan berdasarkan teori Newman. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9(3).*. https://doi.org/10.24127/ajpm.v9i3.2795

Nasution, J. S., Fatonah, S., Sapri, S., & Sakdah, M. S. (2023). Analisis integrasi nilai-nilai Islam dalam pembelajaran di SD Islam Terpadu Al-Fityan Medan Sumatera Utara. *Al-Madrasah: Jurnal Ilmiah Pendidikan Madrasah Ibtidaiyah*, *7*(2), 654–671. https://doi.org/10.35931/am.v7i2.2052

Nawi, R. M., Abdullah, M., Zhaffar, N. M., & Yusop, U. H. (2025). Pedagogical content knowledge of Usul al-Fiqh in the Islamic Syariah Education subject (KSSM) in Malaysia: A literature review. *Global Journal Al-Thaqafah*, *175–187.*. https://doi.org/10.7187/GJATSI112025-11

Nilimaa, J. (2023). New examination approach for real-world creativity and problem-solving skills in mathematics. *Trends in Higher Education*, *2*(3), 477–495. https://doi.org/10.3390/higheredu2030028

Olivares, D., Lupiáñez, J. L., & Segovia, I. (2021). Roles and characteristics of problem solving in the mathematics curriculum: A review. *International Journal of Mathematical Education in Science and Technology*, *52*(7), 1079–1096. https://doi.org/10.1080/0020739X.2020.1738579

Pambudi, D. S., Budayasa, I. K., & Lukito, A. (2020). The role of mathematical connections in mathematical problem solving. *Jurnal Pendidikan Matematika*, *14*(2), 129–144. https://doi.org/10.22342/jpm.14.2.10985.129-144

Prasetyaningrum, H. D., Amir, M. F., & Wardana, M. D. K. (2022). Elementary school students' errors in solving word problems based on Newman error analysis. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11(3).*. https://doi.org/10.24127/ajpm.v11i3.5576

Riwanda, A., Abdurrohim, Widiyati, E., & Pranajaya, S. A. (2026). Science and religion integration in Indonesian Islamic senior high schools: Analyzing teachers' pedagogical practices. *Science & Education*, *35*(1), 261–281. https://doi.org/10.1007/s11191–025–00648-x

Siregar, T., Wijaya, A., Atmini, Abadi, A. M., Suparni, & Rangkuti, A. N. (2024). Hubungan motivasi berprestasi dan kebiasaan belajar dengan hasil belajar matematika siswa kelas X-1 SMAN 1 Padangsidimpuan. *Educofa: Jurnal Pendidikan Matematika*, *1(1).*

Sukoriyanto. (2020). Students' errors analysis in solving the geometry word problem based on Newman stage. *AIP Conference Proceedings*, *2215.*. https://doi.org/10.1063/5.0000490

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of problem-solving strategies in mathematics education supporting the sustainability of 21st-century skills. *Sustainability*, *12(23).*. https://doi.org/10.3390/su122310113

Torres-Peña, R. C., Peña-González, D., Lara-Orozco, J. L., Ariza, E. A., & Vergara, D. (2025). Enhancing numerical thinking through problem solving: A teaching experience for third-grade mathematics. *Education Sciences*, *15(6).*. https://doi.org/10.3390/educsci15060667

Umar, A., Kadarisman, Y. P., & Rahman, Moh. R. (2025). Transformational leadership and STEM achievement in Indonesian madrasahs: Insights from national science competitions. *Leadership and Policy in Schools*, *0*(0), 1–15. https://doi.org/10.1080/15700763.2025.2608044

Umar, A., Kusaeri, K., Ridho, A., & Yusuf, A. (2022). Does opportunity to learn explain the math score gap between madrasah and non-madrasah students in Indonesia? Cakrawala Pendidikan - Jurnal Ilmiah Pendidikan, 41(3), 792–805. https://doi.org/10.21831/cp.v41i3.40169

Utami, I. Q., Hwang, W.-Y., & Hariyanti, U. (2024). Contextualized and personalized math word problem generation in authentic contexts using generative pre-trained transformer and its influences on geometry learning. *Journal of Educational Computing Research*, *62*(6), 1384–1419. https://doi.org/10.1177/07356331241249225

Wiranti, Meiliasar, & Dhianti, L. (2023). Analisis kesalahan siswa dalam menyelesaikan soal cerita pada materi aritmatika sosial berdasarkan tahapan Newman's Error Analysis (NEA) kelas VII SMP Negeri 187 Jakarta. *JURNAL RISET PEMBELAJARAN MATEMATIKA SEKOLAH*, *7(1).*. https://doi.org/10.21009/jrpms.071.08

Yaakob, S. F. B., Kasim, T. S. A. B. T., Razif, N. F. B. M., & Maawali, I. M. Z. A. (2025). Knowledge and teaching practices of Islamic education teachers in learning female blood fiqh of secondary school Islamic education curriculum: Analysis based on contextual learning approach. *Millah: Journal of Religious Studies*, *835–868.*. https://doi.org/10.20885/millah.vol24.iss2.ar9

Yuliany, N., Ulfiani Rahman, & Amriani. (2022). Pengaruh motivasi berprestasi dan kebiasaan belajar terhadap prestasi belajar matematika siswa. *Al Asma: Journal of Islamic Education*, *4(1).*. https://doi.org/10.24252/asma.v4i1.28444