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Quality assessment of mathematics textbooks: Identifying and addressing content mistakes

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Abstract

This study examined the quality of government-issued mathematics textbooks by systematically identifying and analyzing content mistakes that may affect mathematical understanding and instructional effectiveness. Using a qualitative descriptive design with a document analysis approach, 16 secondary school mathematics textbooks were analyzed across five error categories: conceptual, procedural, representational, didactic, and technical errors. The findings revealed that all analyzed textbooks contained errors, with technical errors being the most frequent, while conceptual, procedural, and representational errors posed the greatest instructional risk. To extend existing textbook evaluation approaches, this study integrates error-type classification with an instructional severity analysis, distinguishing between major and minor errors based on their potential impact on learning. The results highlight that textbook quality issues are not limited to editorial inaccuracies but also include substantive mathematical and pedagogical weaknesses. This study contributes a severity-informed framework that can support more targeted textbook revisions, quality assurance, and instructional decision-making in mathematics education.

Keywords: content error analysis; instructional material evaluation; mathematics education; textbook quality assessment

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Introduction

Mathematics textbooks play a central role in shaping curriculum enactment, classroom instruction, and students' opportunities to learn. As primary instructional resources, textbooks not only present mathematical content but also implicitly convey epistemological perspectives, pedagogical orientations, and expectations regarding mathematical rigor (Tarr et al., 2006). Consequently, the quality of mathematics textbooks, particularly in terms of content accuracy, conceptual coherence, and pedagogical alignment has become a critical concern in mathematics education research (Yacob & Landani, 2020). Quality assessment of mathematics textbooks generally involves systematic evaluation of content correctness, clarity of explanations, instructional support, representation of concepts, and alignment with curriculum standards (Zeynivandnezhad et al., 2024). Ensuring high-quality textbooks is therefore essential for supporting effective teaching practices and meaningful student learning.

Empirical evidence suggests that weaknesses in textbook quality may have substantial negative consequences for both teachers and students. Atanga (2021) demonstrated that mathematics textbooks with only medium mathematical quality can result in what is termed mathematical malnourishment, where learners develop fragmented or superficial understanding of mathematical concepts. Given that teachers frequently rely on textbooks as their main instructional guide, inaccuracies or ambiguities in textbooks are often reproduced in classroom explanations and assessment practices (Ngunjiri, 2022). This reliance further amplifies the impact of textbook quality on learning outcomes, as flawed explanations or tasks may reinforce misconceptions rather than promote conceptual understanding (Ngunjiri, 2022). As a result, the assessment of textbook quality is not merely a technical exercise, but a critical component of instructional improvement.

In response to these concerns, various frameworks for evaluating mathematics textbooks have been developed. Zeynivandnezhad et al. (2024) proposed a comprehensive framework encompassing language, content, pedagogy, cultural sensitivity, assessment, and visual representation, while Atanga (2021) introduced the Quality Textbook Assessment System (QTAS), which integrates qualitative and quantitative indicators to assess textbook accuracy and effectiveness. These approaches reflect an increasing recognition that textbook quality must be examined holistically. However, many existing frameworks tend to emphasize structural characteristics and surface-level features, leaving in-depth analysis of mathematical content errors, particularly their nature and instructional implications are relatively underexplored.

Studies conducted across different national contexts reveal recurring content-related problems in mathematics textbooks. Research in Cameroon found that primary mathematics textbooks often lacked multiple solution strategies and representations, limiting opportunities for students to develop flexible mathematical thinking (Atanga, 2021). Similarly, Singh et al. (2020) reported an imbalanced distribution of problem types in Malaysian primary textbooks, which was associated with uneven student performance patterns. In Nigeria, teachers perceived mathematics textbooks as substandard, citing unclear explanations, inappropriate illustrations, and linguistic issues that hindered effective teaching (Fagbola & Onasanya, 2020). Collectively, these findings suggest that content inaccuracies and weaknesses are not isolated phenomena but represent a persistent challenge in mathematics textbook development.

The urgency of systematic textbook quality assessment is further reinforced by research linking textbook characteristics to student achievement and higher-order thinking skills. Textbooks strongly influence teachers' instructional decisions, assessment designs, and classroom discourse, thereby shaping students' mathematical reasoning and problem-solving abilities (Pratama & Retnawati, 2018). High-quality textbooks are widely acknowledged as essential for fostering higher-order thinking skills, which are a key competency in 21st-century education. Conversely, textbooks containing conceptual or procedural errors may obstruct the development of deep understanding and reasoning (Fan et al., 2013). Although previous studies have identified multiple dimensions of textbook quality, such as reliability, aesthetics, contextual relevance, and usability (Fan et al., 2021). While existing frameworks have comprehensively evaluated the structural and linguistic characteristics of textbooks, this study clearly positions itself by deeply analyzing substantive mathematical and pedagogical weaknesses. By integrating error-type classification with an instructional severity analysis, this research extends the current literature to provide targeted, severity-informed revision strategies.

Recent advances in mathematics textbook research indicate a gradual shift from general quality evaluation toward more focused analyses of content errors. Zeynivandnezhad et al. (2024), for instance, incorporated deep content analysis into their evaluation framework, yet their study primarily concentrated on procedural inaccuracies and did not sufficiently address implicit conceptual errors that are often more detrimental to learning. Moreover, the pedagogical consequences of such errors, particularly their role in generating or sustaining student misconceptions, were not examined in depth. Large-scale assessments such as (Cahyono & Adilah, 2016) , along with recent studies by Andriatna & Kurniawati (2024), have highlighted a strong association between textbook errors and persistent student misconceptions, underscoring the need for more refined analytical approaches.

Despite growing awareness of these issues, many existing recommendations for improving mathematics textbooks remain generic and offer limited operational guidance for authors, reviewers, and curriculum developers. In particular, there is a lack of studies that classify content errors based on their severity, examine their instructional impact, and translate these analyses into concrete revision strategies aligned with national curricula. Addressing this gap is crucial for moving beyond descriptive evaluation toward actionable improvement. Therefore, this study seeks to systematically assess the quality of mathematics textbooks by identifying both procedural and conceptual content mistakes, including those that are not immediately visible, and by analyzing their potential impact on students' understanding. By proposing an error-severity-based improvement framework accompanied by concrete revision examples, this research aims to contribute a more practical and theoretically grounded approach to mathematics textbook quality enhancement

Methods

This study employed a qualitative descriptive research design using a document analysis approach to examine the quality of mathematics textbooks, with a focus on identifying and addressing content mistakes. Qualitative descriptive research is suitable for systematically describing phenomena without experimental manipulation (Sandelowski, 2000), while document analysis allows stable instructional materials such as textbooks to be examined for mathematical accuracy, conceptual coherence, and pedagogical clarity (Zeynivandnezhad et al., 2024).

Data sources

The data sources consisted of 16 government-issued mathematics textbooks officially used in junior high schools (SMP) for grades 7 to 9, encompassing both Kurikulum 2013 and Kurikulum Merdeka. The sample size of 16 books was determined based on data saturation, ensuring a comprehensive representation of potential content errors across different curriculum frameworks. The units of analysis included core textbook components such as definitions, worked examples, illustrations, and application problems, which are critical for conceptual and procedural understanding and are often prone to content-related errors (Atanga, 2021).

Research instruments

The data were collected using a structured textbook analysis instrument adapted from established cognitive and pedagogical frameworks in mathematics education. The five error categories (conceptual, procedural, representational, didactic, and technical) were selected to systematically capture both substantive mathematical accuracy and pedagogical alignment. Each category is operationally defined by explicit, measurable indicators—such as alignment with students' Zone of Proximal Development (ZPD) for didactic errors—to minimize subjective judgment and ensure replicability, following principles of qualitative content analysis (Pranyoto & Sujadi, 2015). The operational definitions, indicators, and units of analysis for each error type are presented in Table 1

Table 1. The operational definitions, indicators, and units of analysis for each error type

No.	Error Type	Error Indicators	Reference
1	Conceptual Error	Incorrect definition; misuse of terminology; missing properties; conceptual inconsistency	(Movshovitz-Hadar et al., 1987; Radatz, 1979)
2	Procedural Error	Incorrect steps; invalid algorithm; computational inconsistency	(Ashlock, 2010; Newman, 1977)
3	Representational Error	Mismatch between visual and symbolic forms; use of verbal, symbolic, graphical, or pictorial representations that are misaligned with junior high	(Duval, 2006; Pimm, 1990)

No.	Error Type	Error Indicators	Reference
		school students' cognitive development levels	
4	Didactic Error	Leaps over students' Zone of Proximal Development (ZPD); presence of unintroduced technical terms; lack of prerequisite knowledge activation	(Brousseau, 2002; Vygotsky, 2019)
5	Technical Error	Typographical errors; inconsistent notation; layout issues	(Mayer, 2014; Midgett & Eddins, 2001)

Research procedures

The research followed a systematic document analysis procedure. Initial error identification was conducted by undergraduate students who received two weeks of intensive training on the error taxonomy to reduce subjectivity and improve analytical reliability (Katakara et al., 2024). The supervision mechanism involved weekly collaborative review sessions. Furthermore, inter-rater reliability was calculated using Cohen's Kappa to ensure consistency among analysts before all identified errors were ultimately validated by the researcher as a subject-matter expert, a practice commonly recommended in mathematics textbook analysis studies (Harel, 2017). To enhance methodological clarity and transparency, the overall research procedure is summarized in Figure 1.

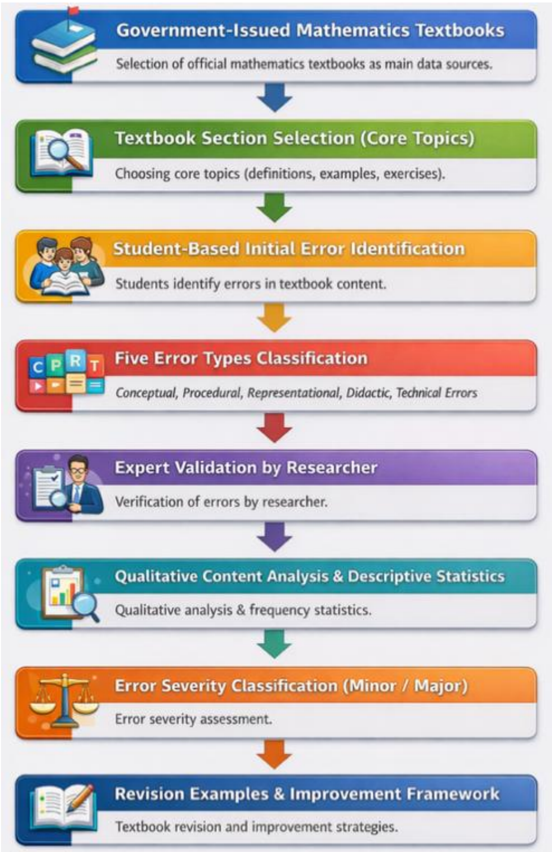


Figure 1. Research procedure

Data collection techniques

Data were collected through systematic content analysis of textbook materials. Initial error identification was conducted by undergraduate students who received two weeks of intensive training on the error taxonomy. The supervision mechanism involved weekly collaborative review sessions, and inter-rater reliability to ensure consistency among analysts. This study was conducted over one academic semester, from January 2025 to June 2025, allowing the research to capture the specific policy context of the curriculum transition during data collection. To enhance credibility and trustworthiness, all reported errors were ultimately re-examined and cross-validated by the researcher against accepted mathematical principles and pedagogical standards, consistent with recommended practices in qualitative document-based research

Data analysis techniques

The validated data were analyzed using qualitative content analysis, supported by descriptive statistics to summarize the distribution of error types. Errors were classified according to the five predefined categories and further grouped by instructional severity. 'Major' errors are operationally defined as those presenting mathematically invalid concepts or violating pedagogical progressions (e.g., exceeding the ZPD), directly causing misconceptions. 'Minor' errors are those affecting aesthetic clarity or formatting without fundamentally altering mathematical truth, thereby minimizing subjective judgment. Representative major errors were then used to formulate an error-severity-based framework for textbook improvement.

Results

General overview of textbook content mistakes

This study analyzed 16 government-issued mathematics textbooks used in secondary schools to identify content-related mistakes that may affect mathematical understanding and instructional quality. The analysis revealed that all examined textbooks contained errors, with a total of 255 identified mistakes across the dataset. The errors varied in type, frequency, and instructional impact, indicating that quality issues were not isolated cases but rather a systematic concern across different textbooks and mathematical topics.

The identified mistakes were classified into five categories: conceptual, procedural, representational, didactic, and technical errors. These categories reflect different dimensions of textbook quality, ranging from deep conceptual accuracy to surface-level presentation and formatting. The presence of errors in all categories suggests that textbook quality issues extend beyond editorial problems and include substantive mathematical and pedagogical weaknesses.

Frequency and distribution of error types

The overall distribution of error types is presented in Table 2. Technical errors were the most frequently identified category, accounting for 98 occurrences (38.4%), followed by didactic errors (42 occurrences, 16.5%), representational errors (41 occurrences, 16.1%), procedural errors (40 occurrences, 15.7%), and conceptual errors (34 occurrences, 13.3%). Although technical errors dominated in frequency, the combined proportion of conceptual, procedural, and representational errors exceeded 45%, indicating a substantial presence of errors with direct instructional consequences.

Table 2. Distribution of content mistakes by error type

Error Type	Frequency	Percentage (%)
Conceptual Errors	34	13.3
Procedural Errors	40	15.7
Representational Errors	41	16.1
Didactic Errors	42	16.5
Technical Errors	98	38.4
Total	**255**	**100.0**

Conceptual errors

A total of 34 conceptual errors were identified across the analyzed textbooks. These errors primarily appeared in definitions of mathematical concepts, explanations of fundamental ideas, and statements of properties or conditions. Conceptual errors were frequently associated with abstract mathematical topics, where precision in definitions and logical consistency is essential for student understanding.

Several conceptual errors involved incomplete definitions, where essential properties or conditions were omitted, potentially leading students to form incorrect generalizations. Other errors reflected misuse of mathematical terminology or internal inconsistencies between definitions and subsequent explanations within the same chapter. Such errors may undermine the conceptual coherence of the textbook and create confusion when students attempt to connect related ideas.

Ingat jika diberikan sistem persamaan $\begin{cases} ax+by=c \\ px+qy=r \end{cases}$ dengan $\frac{a}{p}=\frac{b}{q}\neq\frac{c}{r}$, maka sistem persamaan linear tersebut mempunyai

Recall that if a system of equations $\begin{cases} ax+by=c \\ px+qy=r \end{cases}$ is given with $\frac{a}{p}=\frac{b}{q}\neq\frac{c}{r}$, then the linear system has no solution.

Figure 2. Example of a conceptual error

The error in this statement lies in the lack of clarity and precision in formulating the conditions for comparing coefficients in a system of linear equations in two variables. The statement $\frac{a}{p}=\frac{b}{q}\neq\frac{c}{r}$ is actually a special case, namely when the system has no solution. However, in its presentation, this condition is not accompanied by an explicit explanation of the type of solution in question, thus creating ambiguity. Furthermore, the use of equal and not equal signs in a single sequence without systematic case separation has the potential to confuse readers, especially students who are still developing their conceptual understanding.

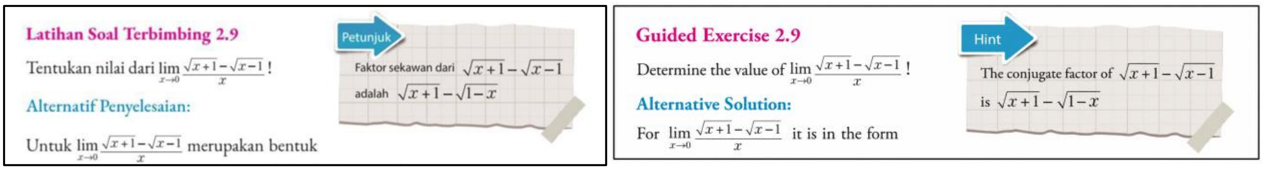
Conceptually, a system of linear equations in two variables must be explained through three distinct possible conditions. First, if $\frac{a}{p}\neq\frac{b}{q}$, then the system has one (unique) solution. Second, if $\frac{a}{p}=\frac{b}{q}=\frac{c}{r}$, then the system has infinitely many solutions. Third, if $\frac{a}{p}=\frac{b}{q}\neq\frac{c}{r}$, then the system has no solution. Therefore, writing that presents only one of these conditions without a complete context can lead to misunderstandings of the overall concept.

The impact of this error is quite significant in learning. Students may develop misconceptions regarding the classification of solutions to systems of linear equations, potentially leading to errors in selecting solution methods—such as persistently seeking solutions for a system that actually has none, or failing to recognize the existence of infinite solutions. Furthermore, this error can also disrupt the underlying geometric understanding, such as the interpretation of relationships between lines (intersecting, parallel, or coincident). If not corrected promptly, these misconceptions can carry over into more advanced material, such as systems of linear equations in matrix form and determinants, thereby affecting overall mathematical understanding.

Procedural errors

The analysis identified 40 procedural errors, most of which occurred in worked examples and step-by-step solution procedures. These errors included incorrect sequences of operations, invalid algorithms, and inconsistent computational steps. Procedural errors are particularly critical because worked examples are intended to serve as models for correct problem-solving strategies.

In several cases, incorrect procedures produced numerically correct final answers, masking underlying flaws in reasoning. Such errors may encourage rote imitation without understanding and increase the likelihood of procedural misconceptions. Procedural mistakes were most frequently found in problem-solving sections involving algebraic manipulation, numerical computation, and applied problem contexts. Figure 3 presents an example of a conceptual error originally identified in the textbook's procedural section, showing the incorrect rationalization of a radical expression alongside a fundamental flaw in the function's domain


Latihan Soal Terbimbing 2.9

Tentukan nilai dari $\lim_{x\to 0} \frac{\sqrt{x+1}-\sqrt{x-1}}{x}$!

Alternatif Penyelesaian:

Untuk $\lim_{x\to 0} \frac{\sqrt{x+1}-\sqrt{x-1}}{x}$ merupakan bentuk

Petunjuk

Faktor sekawan dari $\sqrt{x+1}-\sqrt{x-1}$ adalah $\sqrt{x+1}-\sqrt{1-x}$

Guided Exercise 2.9

Determine the value of $\lim_{x\to 0} \frac{\sqrt{x+1}-\sqrt{x-1}}{x}$!

Alternative Solution:

For $\lim_{x\to 0} \frac{\sqrt{x+1}-\sqrt{x-1}}{x}$ it is in the form

Hint

The conjugate factor of $\sqrt{x+1}-\sqrt{x-1}$ is $\sqrt{x+1}-\sqrt{1-x}$

Figure 3. Example of procedural error

The error lies in determining the common factor of the form $\sqrt{x+1}-\sqrt{x-1}$. In the material, the common factor is written by changing the form to $\sqrt{1-x}$, which is conceptually not equivalent to the original form. This indicates a fundamental misconception regarding the definition of a common factor in radical form. Mathematically, the common factor of $a-b$ is $a+b$ without changing the structure of each term. In this case, the correct common factor should be $\sqrt{x+1}-\sqrt{x-1}$, not by modifying the content of the radical.

This error is not only procedural but also conceptual. Changing $\sqrt{x-1}$ to $\sqrt{1-x}$ implies a different domain of the function and can even cause the form to become undefined in real terms for certain values x. If this error is not addressed critically, students could potentially develop the misconception that common factors can be obtained by freely manipulating the contents of the radical, rather than based on standard algebraic principles. In the long term, this could hinder their understanding of limits, rationalizing radical forms, and other algebraic operations.

As a recommendation for improvement, teaching materials need to reaffirm the basic concept of common factors through a general definition: a pair of the form $a - b$ and $a + b$ whose multiplication yields a difference of squares. Furthermore, it is important to systematically and consistently explain the rationalization steps, starting with identifying the indeterminate form, selecting the appropriate common factors, and simplifying the result. To avoid misconceptions, it is also recommended to include comparative examples of correct and incorrect use of common factors so that students can explicitly understand the errors. Thus, teaching materials not only present procedures but also build a strong and accurate conceptual understanding.

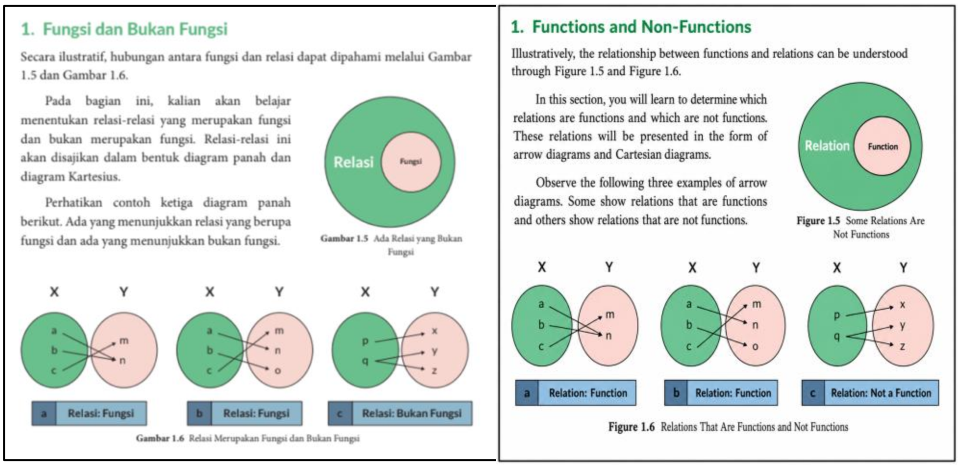
The problem $\lim_{x \to 0} \frac{\sqrt{x+1} - \sqrt{x-1}}{x}$ is fundamentally conceptually flawed. The expression $\sqrt{x-1}$ is not defined in real numbers for $x \to 0$, as the domain requires $x \geq 1$. Therefore, the primary error is a conceptual error regarding the function domain, not merely a procedural error. Furthermore, the textbook is mathematically incorrect in identifying the conjugate; the conjugate of $\sqrt{x+1} - \sqrt{x-1}$ is $\sqrt{x+1} + \sqrt{x-1}$, not $\sqrt{x+1} - \sqrt{1-x}$.

Representational errors

A total of 41 representational errors were identified, involving inconsistencies between visual representations, symbolic notation, and verbal explanations. These errors were observed in graphs, diagrams, tables, and symbolic expressions. In several instances, diagrams did not accurately reflect the conditions described in the text, or symbols were used inconsistently across representations.

Representational errors are particularly problematic because mathematics learning relies heavily on the coordination of multiple representations. When visual and symbolic elements convey conflicting information, students may struggle to interpret concepts correctly or fail to recognize underlying mathematical relationships.

The representational error in the Figure 4 lies primarily in the absence of clear and explicit labelling of the domain and codomain in the arrow diagrams. Although two sets are denoted (e.g., X and Y), the material does not clearly define which set serves as the domain and which as the codomain. This ambiguity weakens the mathematical meaning of the representation, as the concept of a function fundamentally depends on a well-defined mapping from a domain to a codomain. As a result, students may interpret the diagram merely as a general relation rather than a formal function.



1. Fungsi dan Bukan Fungsi

Secara ilustratif, hubungan antara fungsi dan relasi dapat dipahami melalui Gambar 1.5 dan Gambar 1.6.

Pada bagian ini, kalian akan belajar menentukan relasi-relasi yang merupakan fungsi dan bukan merupakan fungsi. Relasi-relasi ini akan disajikan dalam bentuk diagram panah dan diagram Kartesius.

Perhatikan contoh ketiga diagram panah berikut. Ada yang menunjukkan relasi yang berupa fungsi dan ada yang menunjukkan bukan fungsi.

Gambar 1.5 Ada Relasi yang Bukan Fungsi

Gambar 1.6 Relasi Merupakan Fungsi dan Bukan Fungsi

1. Functions and Non-Functions

Illustratively, the relationship between functions and relations can be understood through Figure 1.5 and Figure 1.6.

In this section, you will learn to determine which relations are functions and which are not functions. These relations will be presented in the form of arrow diagrams and Cartesian diagrams.

Observe the following three examples of arrow diagrams. Some show relations that are functions and others show relations that are not functions.

Figure 1.5 Some Relations Are Not Functions

Figure 1.6 Relations That Are Functions and Not Functions

Figure 4. Example of representational error

In addition, the material does not incorporate formal function notation, such as f: A → B, nor does it provide an explicit explanation of the meaning of the arrows. The arrows are presented only as visual links between elements without clarifying that each element in the domain must map to exactly one element in the codomain. This lack of explanation becomes more problematic when multiple arrows appear, as the material does not explicitly address why such cases may violate the definition of a function. Consequently, students may fail to grasp the essential properties that distinguish functions from non-functions.

Furthermore, the elements within the sets are introduced without sufficient context, and the connection between the diagrams and the underlying concept is not clearly articulated. Although the examples are labeled as "function" and "not a function," the reasoning behind these classifications is not explicitly represented within the diagrams themselves. This indicates a lack of coherence between visual, symbolic, and conceptual representations, which may lead students to rely on intuition rather than a solid understanding of the formal definition of a function.

Didactic errors

The study identified 42 didactic errors, which were related to the instructional organization and pedagogical clarity of textbook content. These errors included illogical sequencing of topics, insufficient scaffolding between prerequisite and new concepts, and explanations that did not align with students assumed prior knowledge.

Didactic errors were particularly evident in introductory sections of chapters, where key prerequisite concepts were either omitted or insufficiently reviewed. In some cases, complex ideas were introduced abruptly without intermediate explanations or illustrative examples, potentially increasing cognitive load and hindering comprehension.

Pertanyaan Pemantik

- Apakah setiap relasi merupakan fungsi?
- Apa peran domain, kodomain, dan *range* dari sebuah fungsi?
- Bagaimana menerapkan operasi dan komposisi fungsi untuk memodelkan suatu keadaan atau masalah?
- Kapan fungsi *invers* dapat diperoleh?
- Bagaimana menggunakan fungsi *invers* untuk memodelkan suatu keadaan atau masalah?

Guiding Questions

- Is every relation a function?
- What are the roles of the domain, codomain, and range of a function?
- How can function operations and function composition be applied to model a situation or problem?
- When can an inverse function be obtained?
- How can an inverse function be used to model a situation or problem?

Figure 5. Example of didactical error

The guiding questions in Figure 5 are pedagogically problematic not simply because they are 'too difficult,' but because they leap over the students' Zone of Proximal Development (ZPD). They employ technical terminology (domain, codomain, range, composition, inverse) not yet introduced, lacking necessary scaffolding from prerequisite knowledge such as relations, sets, and arrow diagrams. The error is a misalignment between cognitive demands and assumed prior knowledge.

To address this issue, the guiding questions should be redesigned to align with students' prior knowledge and gradually lead them toward formal concepts. The lesson could begin with contextual or intuitive questions, such as everyday situations involving input-output relationships, simple mappings, or real-life examples of pairing objects. From there, the questions can be sequenced progressively—from identifying simple relations, to recognizing patterns, and eventually to formalizing the idea of functions, composition, and inverses. By incorporating scaffolding and contextualization, the questions will more effectively serve their purpose as entry points into learning, encouraging participation and supporting conceptual development.

Technical errors

Technical errors were the most prevalent, with 98 occurrences identified across the textbooks. These errors included typographical mistakes, inconsistent mathematical notation, formatting issues, and layout inconsistencies. Although technical errors are often considered minor, their high frequency suggests a lack of editorial rigor and may negatively affect readability and learner confidence.

Repeated inconsistencies in notation were found to be particularly problematic, as they may cause confusion when students encounter the same symbol used with different meanings in nearby sections of the text.

Limit merupakan salah satu konsep matematika yang dapat digunakan untuk menyelesaikan permasalahan seperti yang terjadi pada Karapan Sapi dan Pacu Jawi. Pada bab Limit akan membahas tentang limit fungsi aljabar dan limit fungsi trigonometri. Faktor penting dalam mempelajari limit adalah kalian harus memahami konsep dan definisi limit, termasuk sifat-sifat limit.

Bagaimanakah menerapkan konsep dasar limit dalam menyelesaikan permasalahan? Adakah permasalahan bentuk lain yang dapat diselesaikan menggunakan konsep limit? Semua pertanyaan tersebut akan terjawab ketika kalian mempelajari materi pada bab ini.

Pertanyaan Pemantik

1. Bagaimanakah menentukan limit fungsi?
2. Bagaimanakah menerapkan sifat-sifat limit fungsi dalam menentukan nilai limit fungsi?
3. Bagaimanakah menerapkan konsep dasar limit fungsi dalam menyelesaikan masalah sehari-hari?

Limit is one of the mathematical concepts that can be used to solve problems such as those found in Karapan Sapi and Pacu Jawi. In this chapter on Limits, you will study limits of algebraic functions and limits of trigonometric functions. An important factor in learning limits is that you must understand the concept and definition of limits, including the properties of limits.

How can the basic concept of limits be applied to solve problems? Are there other types of problems that can be solved using the concept of limits? All of these questions will be answered when you study the material in this chapter.

Guiding Questions

1. How do you determine the limit of a function?
2. How do you apply the properties of limits of functions to determine the value of a function limit?
3. How do you apply the basic concept of function limits to solve everyday problems?

Figure 6. Example of technical error

The use of the phrase "*Bagaimanakah…*" in guiding questions is grammatically correct and formal; however, it tends to sound rigid and less engaging in the context of interactive classroom learning. Such phrasing may create a sense of distance between the material and the students, making the questions feel more like formal examinations rather than invitations to think and explore. In student-centered learning environments, especially at the beginning of a lesson, language plays a crucial role in encouraging participation and reducing cognitive barriers.

Replacing it with the phrase "*Bagaimana cara…*" makes the questions more communicative, natural, and approachable. This alternative phrasing aligns better with conversational language commonly used in classrooms, helping students feel more comfortable and willing to respond. It also emphasizes procedural thinking ("how to do") rather than abstract inquiry, which is more suitable for activating prior knowledge and guiding students into the learning process in an interactive and engaging manner.

Error severity analysis

Errors were further classified based on instructional severity into major and minor categories. Major errors consisted primarily of conceptual, procedural, and representational mistakes that had the potential to directly cause misconceptions or incorrect problem-solving strategies. Minor errors were largely technical and some didactic errors that affected clarity, formatting, or presentation without directly altering mathematical meaning. Table 3 ummarizes the classification of errors based on instructional severity.

Table 3. Classification of errors by instructional severity

Error Severity	Dominant Error Types	Description
Major	Conceptual, Procedural, Representational	Errors with direct impact on mathematical understanding
Minor	Technical, Didactic	Errors affecting clarity, structure, and presentation

Based on the frequency and severity of the identified errors, revision examples were formulated to demonstrate appropriate corrective actions. Table 4 presents selected examples linking error types to recommended revision strategies.

Table 4. Error types and suggested revisions

Error Type	Common Issue Identified	Suggested Improvement
Conceptual	Imprecise definitions	Reformulate using formal mathematical language
Procedural	Incorrect solution steps	Provide logically sequenced steps with justification
Representational	Inconsistent graphs or symbols	Standardize representations and labels
Didactic	Lack of explanatory scaffolding	Add intermediate explanations
Technical	Typographical and notation errors	Apply systematic proofreading and notation checks

These examples form an improvement framework that prioritizes error correction based on instructional impact, supporting systematic textbook revision and quality assurance. The findings indicate that errors were present in all analyzed textbooks and distributed across five categories, suggesting that textbook quality issues are both widespread and multidimensional. This confirms that textbooks, despite being authoritative instructional resources, are not immune to mathematical and pedagogical inaccuracies, as also reported in prior textbook evaluation studies (Fan, 2013).

Discussion

One of the most prominent findings is the high prevalence of technical errors, which accounted for more than one-third of all identified mistakes. Although technical errors are often classified as minor, their cumulative presence may negatively affect students' reading fluency and trust in textbooks as reliable learning sources, particularly when notation inconsistencies occur repeatedly (Norberg, 2023; Rezat, 2024; Sugiarni et al., 2024). This finding confirms the work of Wijayanti et al. (2025) and extends previous research by demonstrating that formatting issues persist across different curriculum versions (Fan et al., 2025; Rezat, 2024). Conversely, while Atanga (2021) found conceptual errors to be the most prevalent in primary textbooks, this study contradicts that pattern by identifying technical errors as the most frequent in secondary textbooks, likely due to differences in educational levels and national editorial review processes. Ultimately, this study contributes to the field by providing a severity-informed framework that translates error identification into concrete revision strategies (Zeynivandnezhad et al., 2024)

In addition to technical issues, the substantial occurrence of didactic errors highlights weaknesses in instructional design and pedagogical coherence. Errors related to illogical sequencing and insufficient scaffolding suggest misalignment with established principles of effective mathematics instruction, which emphasize gradual conceptual progression and learner-oriented explanations (Brunner & Star, 2024; Fardian et al., 2025). This finding refines earlier research by showing that pedagogical shortcomings persist even in officially endorsed textbooks, indicating systemic instructional design issues rather than isolated editorial problems (Juhaevah et al., 2025).

More critically, the identification of conceptual, procedural, and representational errors, which together constituted nearly half of the total errors, raises serious concerns regarding the instructional reliability of the analyzed textbooks (Brunner & Star, 2024; Sievert et al., 2021). Conceptual errors involving incorrect or incomplete definitions are particularly problematic, as they may lead to persistent misconceptions in abstract mathematical topics (Lenz et al., 2024; Tularam & Hassan, 2025). Procedural errors found in worked examples are equally concerning because examples function as primary models for students' problem-solving strategies; incorrect procedures may therefore reinforce flawed reasoning, even when final answers appear correct (Barbieri et al., 2023; Dorner et al., 2026; Radatz, 1979).

Representational errors further compound these issues by disrupting the coordination between symbolic, visual, and verbal representations. Prior research has emphasized that representational consistency is essential for conceptual understanding in mathematics, as students rely on multiple representations to build meaning (Vangsøe Færch, 2025; Yacob & Landani, 2020). The coexistence of representational inconsistencies with conceptual and procedural errors suggests that textbook mistakes should not be treated as isolated phenomena but as interacting factors that collectively shape students' opportunities to learn mathematics (Rezat, 2024).

From a theoretical perspective, these findings align with constructivist learning theory, which posits that learners actively construct knowledge based on the instructional representations and explanations they encounter (Fan et al., 2021). When textbooks contain inaccurate concepts, flawed procedures, or inconsistent representations, students may construct incomplete or incorrect mental models (Norberg, 2023). This reinforces the argument that textbook accuracy is not merely an editorial concern but a fundamental pedagogical issue (Efriyanti et al., 2022; Fan et al., 2025; Rezat, 2024).

A key novelty of this study lies in the integration of error-type classification with instructional severity analysis. While previous studies have primarily focused on identifying and categorizing textbook errors (Atanga, 2021), this study extends the literature by distinguishing between major and minor errors based on their potential impact on learning. This severity-based perspective provides a more nuanced and actionable framework for textbook evaluation, enabling authors, reviewers, and policymakers to prioritize revisions that address errors with the greatest instructional consequences (Zeynivandnezhad et al., 2024). The use of trained undergraduate students for initial error identification, followed by expert validation, supports previous recommendations for collaborative qualitative analysis combined with expert review to enhance credibility and analytical rigor. However, this approach also has limitations, as the identification of subtle conceptual nuances remains highly dependent on expert judgment. Future research could strengthen this design by incorporating inter-rater reliability measures or involving multiple experts to further enhance methodological robustness (Wijaya et al., 2025).

Overall, this study confirms and extends existing research on mathematics textbook quality by providing a comprehensive, severity-informed analysis of content mistakes in government-issued textbooks. The findings underscore the need for more rigorous quality assurance mechanisms in textbook development and review processes, particularly with respect to conceptual accuracy, procedural correctness, and representational consistency (Brunner & Star, 2024; Sievert et al., 2021). Practically, the proposed error-severity-based framework offers a valuable diagnostic tool for improving textbook quality and supporting more effective mathematics learning experiences (Rezat, 2024; Zeynivandnezhad et al., 2024).

Conclusion

This study investigated the quality of government-issued mathematics textbooks by identifying and analyzing content mistakes that may affect mathematical understanding and instructional effectiveness. The findings show that errors were present in all analyzed textbooks and spanned conceptual, procedural, representational, didactic, and technical dimensions, demonstrating that textbook quality issues are both widespread and multifaceted. Notably, the substantial occurrence of conceptual, procedural, and representational errors indicates that inaccuracies extend beyond surface-level presentation problems and may directly influence students' conceptual development and problem-solving processes, thereby addressing the study's primary research objective.

This research advances the field of mathematics education by integrating error-type classification with instructional severity analysis to provide a more nuanced framework for textbook evaluation. By distinguishing between major and minor errors based on their potential impact on learning, the study extends existing textbook analysis approaches and offers a clearer understanding of how different types of mistakes interact to shape students' opportunities to learn mathematics. The findings also reinforce theoretical perspectives that emphasize the importance of conceptual accuracy, procedural correctness, and representational consistency in supporting meaningful mathematical learning.

From a practical perspective, the results have important implications for textbook authors, reviewers, educators, and policymakers. The proposed error-severity-based framework can support more rigorous textbook review and revision processes by prioritizing errors with the greatest instructional consequences, while also encouraging educators to engage critically with textbook content during classroom implementation. Despite limitations related to the scope of textbook selection and expert validation procedures, this study provides a scientifically grounded contribution to understanding textbook quality and suggests directions for future research, including broader comparative analyses and investigations into the relationship between textbook errors and students' learning outcomes.

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Declarations

Conflicts of Interest	:	The authors declare no conflict of interest.
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