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Errors, Representations, and Instructional Coherence in a Secondary Mathematics Textbook: Evidence from the Grade 10 Curriculum in the Kurdistan Region of Iraq

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Abstract

Mathematics textbooks are central to classroom instruction and play a crucial role in supporting students' conceptual understanding of mathematical ideas. Because textbooks often serve as the primary instructional resource, errors in their content may contribute to misconceptions, impede learning, and negatively affect students' mathematical reasoning and problem-solving abilities. This study aimed to identify and analyze errors in the Grade 10 mathematics textbook used in secondary schools in the Kurdistan Region of Iraq during the 2015–2025 curriculum implementation period. A qualitative document analysis approach was employed through a systematic examination of textbook chapters, lessons, worked examples, exercises, graphical representations, and explanatory sections. The identified errors were classified into four categories: incorrectly solved examples, instructional and conceptual deficiencies, printing and graphical errors, and translation- or language-related errors. The analysis revealed eleven errors, including ten major errors and one minor error. Several of these errors were found to have the potential to adversely influence students' conceptual understanding and mathematical performance. The findings highlight the importance of rigorous textbook evaluation and quality assurance procedures to ensure the accuracy, clarity, and pedagogical effectiveness of mathematics instructional materials in secondary education.

Keywords: Curriculum Errors; High School Students; Mistakes; Secondary Mathematics Textbook

Introduction

Mathematics is widely recognized as a foundational discipline for developing logical reasoning, critical thinking, and problem-solving competencies, which are essential for participation in contemporary educational and societal contexts. Within secondary education, mathematics textbooks constitute one of the most influential instructional resources, serving as a primary reference for both teachers and students during classroom instruction. Consequently, the quality, clarity, and accuracy of textbook content are critical determinants of students' conceptual understanding, procedural fluency, and overall mathematical achievement. Errors embedded within mathematics textbooks may contribute to misconceptions, generate confusion, and hinder students' problem-solving processes, particularly when textbook examples and exercises are used as authoritative models for learning mathematical concepts and procedures.

In the Kurdistan Region of Iraq, mathematics education at the secondary-school level continues to encounter a range of instructional challenges, including weaknesses in curriculum design, limitations in educational resources, and persistently low levels of student achievement in mathematics (Waswa & Al-Kassab, 2023a; Waswa et al., 2024). Previous studies have indicated that many students experience difficulties in understanding mathematical concepts and applying appropriate strategies to solve mathematical problems, partly as a consequence of systemic educational constraints and shortcomings in instructional materials (Kakashekh & Mirdan, 2023). Within this context, the quality of mathematics textbooks becomes particularly significant because textbooks shape how mathematical knowledge is organized, represented, communicated, and practiced in classroom settings.

A substantial body of research has examined mathematical errors and misconceptions from various perspectives. For example, Zhao and Acosta-Tello (2016) investigated the effects of erroneous examples on students' understanding of algebraic equation solving and found that incorrect examples can significantly influence students' procedural reasoning. Similarly, Pomalato et al. (2020) analyzed students' errors in solving fraction problems and reported that both conceptual and procedural misunderstandings frequently emerge during mathematical problem-solving. Supardi et al. (2021) further demonstrated that students often struggle with higher-order thinking tasks because of weak conceptual understanding and an overreliance on memorization rather than mathematical reasoning.

Research focusing on specific mathematical domains has likewise documented the prevalence of misconceptions and procedural difficulties among learners. Arhin and Hokor (2021), for instance, identified transformation and processing errors among secondary-school students solving trigonometric problems, whereas Saputra and Cesaria (2023) reported that students frequently encounter difficulties in algebraic operations due to inadequate conceptual understanding. Furthermore, Xu (2023) emphasized that the systematic identification and analysis of mathematical errors can provide valuable insights into students' cognitive processes and contribute to the improvement of mathematical learning and problem-solving performance.

Beyond studies of students' mathematical errors, previous research has highlighted broader challenges affecting mathematics education in Iraq and the Kurdistan Region. Waswa

and Al-Kassab (2023b) reported that overcrowded classrooms, limited instructional support, and students' difficulties maintaining concentration negatively affect mathematics achievement among secondary-school students. Similarly, Waswa et al. (2024) found that instructional practices and students' attitudes toward mathematics are significant factors influencing academic performance and mathematical self-confidence. Although these studies provide important insights into the challenges confronting mathematics education, relatively little attention has been directed toward examining the accuracy and instructional quality of the official mathematics textbooks used in Iraqi secondary schools.

The existing literature has predominantly focused on students' misconceptions, problem-solving difficulties, and teachers' instructional perspectives, whereas comparatively few studies have investigated errors embedded within the textbooks themselves. Nevertheless, textbook-related errors, including incorrect solutions, misleading graphical representations, translation inaccuracies, and insufficient conceptual explanations, may directly contribute to students' misunderstandings and learning difficulties. Given the central role of textbooks in guiding classroom instruction and independent learning, the identification and evaluation of such errors are essential for enhancing the effectiveness and quality of mathematics education.

Accordingly, this study aims to identify and analyze errors contained in the Grade 10 mathematics textbook used in secondary schools in the Kurdistan Region of Iraq during the 2015–2025 curriculum implementation period. Specifically, the study examines four categories of errors: incorrectly solved examples, instructional and conceptual deficiencies, printing and graphical errors, and translation- or language-related inaccuracies. Through a systematic analysis of these errors, the study seeks to contribute evidence-based recommendations for curriculum developers, textbook authors, teachers, and policymakers to improve the accuracy, clarity, and pedagogical quality of mathematics textbooks and, ultimately, to support more effective mathematics teaching and learning in secondary education.

Methods

This study employed a qualitative document analysis design to identify and examine errors contained in the Grade 10 mathematics textbook used in secondary schools in the Kurdistan Region of Iraq during the 2015–2025 curriculum implementation period. Qualitative document analysis is a well-established approach for investigating educational materials because it enables researchers to systematically examine the accuracy, consistency, and pedagogical quality of curriculum documents and textbooks. Given the central role of textbooks in shaping classroom instruction and students' learning experiences, this methodological approach was considered appropriate for evaluating potential inaccuracies and instructional weaknesses embedded within the textbook.

Data Source and Data Collection

The primary source of data was the official Grade 10 mathematics textbook prescribed for use in secondary schools throughout the Kurdistan Region of Iraq. As the principal instructional

resource used by teachers and students, the textbook represents an important medium through which mathematical knowledge is communicated, interpreted, and practiced.

Data collection was conducted through a systematic and comprehensive review of the textbook content. Each chapter, lesson, worked example, exercise, graphical representation, and explanatory section was examined page by page to identify potential errors that could adversely affect teaching and learning processes. Particular attention was directed toward mathematical procedures, solution methods, graphical accuracy, language clarity, instructional sequencing, and conceptual coherence. Whenever a potential error was identified, detailed records were maintained, including the chapter, lesson, page number, example or exercise number, nature of the error, and the corresponding correction or clarification.

Error Classification

Following the identification process, the errors were classified according to their characteristics and potential educational implications. Four categories of errors were established:

1. Incorrectly solved examples, including inaccurate calculations, erroneous mathematical procedures, incorrect graphical representations, or incorrect final answers;
2. Conceptual or instructional deficiencies, referring to concepts, procedures, or exercises introduced without sufficient explanation, justification, or prior instructional support;
3. Printing and formatting errors, including technical inaccuracies such as graph orientation problems, misspelled mathematical terminology, and inconsistencies in formatting or notation; and
4. Translation- and language-related errors, encompassing ambiguous wording, grammatical inaccuracies, and unclear English expressions that could impede students' understanding of mathematical content.

This classification framework facilitated a systematic analysis of the different forms of errors and their potential influence on mathematics teaching and learning.

Data Analysis

The collected data were analyzed using descriptive qualitative analysis. After identifying and categorizing the errors, each case was examined to determine its potential impact on students' conceptual understanding, mathematical reasoning, problem-solving processes, and classroom instruction. Particular attention was given to the extent to which the identified errors might contribute to misconceptions or interfere with students' development of accurate mathematical understanding.

To further evaluate their educational significance, the errors were subsequently categorized as either major or minor. Major errors were defined as inaccuracies with the potential to generate misconceptions, promote incorrect mathematical reasoning, or substantially hinder conceptual understanding. Minor errors were defined as technical, typographical, or formatting issues with relatively limited implications for students' learning outcomes.

Trustworthiness of the Analysis

Several procedures were employed to enhance the credibility and trustworthiness of the analysis. First, the textbook was reviewed repeatedly to ensure consistency in error identification, classification, and interpretation. Second, all mathematical procedures, graphical representations, and explanatory sections were cross-checked against established mathematical principles and accepted instructional standards. Third, relevant literature on mathematics education, textbook evaluation, and error analysis was consulted to support the interpretation of findings and to strengthen the theoretical and methodological grounding of the study.

Ethical Considerations

This study involved the analysis of publicly available educational materials and did not include human participants. Consequently, no ethical risks were associated with the research process, and formal ethical approval was not required. The study was conducted with the objective of providing constructive evidence-based recommendations to improve the accuracy, clarity, and pedagogical effectiveness of mathematics textbooks used in secondary education within the Kurdistan Region of Iraq.

Results and Discussion

Identification and Classification of Textbook Errors

The analysis of the Grade 10 mathematics textbook revealed a range of errors with the potential to influence both students' mathematical learning and teachers' instructional practices. Through a systematic examination of the textbook, a total of eleven errors were identified, comprising ten major errors and one minor error. These errors were distributed across several chapters and lessons and were classified into four categories: (a) incorrectly solved examples, (b) conceptual or instructional deficiencies, (c) printing and graphical errors, and (d) translation- and language-related errors. Table 1 summarizes the identified errors, their locations within the textbook, their classification, and the corresponding corrections.

Table 1. The identified mistakes and the category in which they are classified

Chapter	Lesson	Page	Example/Exercise	Type of Error	Description
1	Two	Example 3		Incorrectly solved	Solution and graph do not match. Correct answer: x=1.95, see Figure 1.
1	Three	17	Example 3	Incorrectly solved	In the solution, 3 x 1/3h ≥ 1/3 x 33 is wrong. Correct answer: 3 x 1/3h ≥ 33 x 3,

Chapter	Lesson	Page	Example/Exercise	Type of Error	Description
1	Three	20	Exercise 34	Specific types of exercise are introduced without context beforehand	The answer to the exercise is no solution, but this has not been explained in the lesson.
3	Two	115	Zero-Product Property box	Printing Error	Minor error; under the box, misspelled the words "solve" and "equation"
4	Two	158	Exercise 35	Printing Error	The negative x-axis is placed on the right of the graph. Correct answer: negative x-axis on the left side of the graph, see Figure 2.
5	One	184-185	Inverse function graph & example 2 graph	Printing error	The negative x-axis is placed on the right of the graph. Correct answer: negative x-axis on the left side of the graph.
5	One	186	Exercise 20-21	Printing error	Questions asks for the values of y instead of x. Correct answer: should ask for the value of x in both questions.
6	One	227	Example 1	Translation error	Poor English is used in the question. Correct answer: "What is the probability of an infected person with lung cancer recovering, knowing that a study has been conducted on 5000 cases, where 250 persons recovered?"

Chapter	Lesson	Page	Example/Exercise	Type of Error	Description
6	Two	240	Exercise 24	Translation error	Informal and poor English was used in the last sentence of the question. Correct answer: "An eyeglass seller wants to display 7 kinds of sunglasses on a circular form. In how many different ways can he arrange them?"
6	Five	254	Exercise 17-20	Translation error	Poor and confusing English is used in the last sentence of the question. Correct answer: "Find the probability of each event in three spins of the spinner." Which could be written as: "Find the probability of each event when the spinner is spun three times."
8	One	326	Example 2	Incorrectly solved	The question asks to find each side length of the triangle given on the right. However, there are no specific side measurements or names on the triangle, and the solution starts using "A, B, and C" as it had been given in the triangle. See Figure 3.

The findings suggest that many of the identified errors extend beyond simple typographical mistakes and may contribute to misconceptions, conceptual confusion, and inconsistencies in the learning process. Several errors directly affect mathematical procedures, representations, and reasoning, whereas others diminish the clarity and effectiveness of

instructional explanations. Collectively, these issues raise concerns regarding the accuracy and pedagogical quality of the textbook as a learning resource.

Incorrectly Solved Examples

One of the most significant findings of this study was the presence of incorrectly solved mathematical examples. Worked examples constitute a fundamental component of mathematics instruction because they provide students with models for understanding procedures, developing solution strategies, and applying mathematical concepts. Consequently, inaccuracies in worked examples may have substantial implications for students' learning.

For example, in Chapter 1, Lesson Two, Example 3, the graphical representation did not correspond to the algebraic solution presented in the text. The value of (x) shown in the graph differed from that obtained through the written solution, whereas the correct solution should yield (x = 1.95) (Figure 1). Such inconsistencies may weaken students' understanding of the relationship between algebraic and graphical representations and hinder their ability to connect multiple forms of mathematical representation.

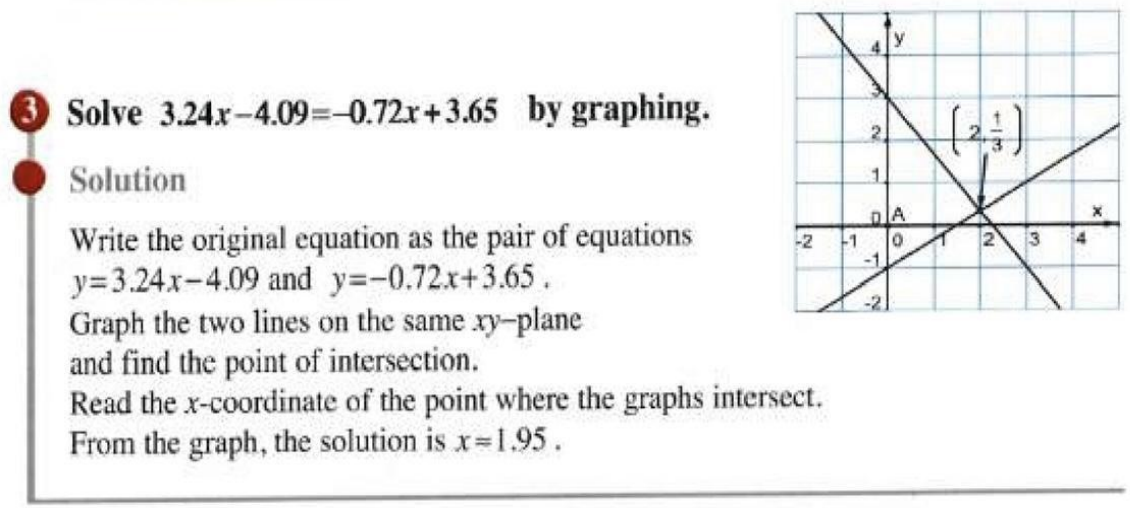
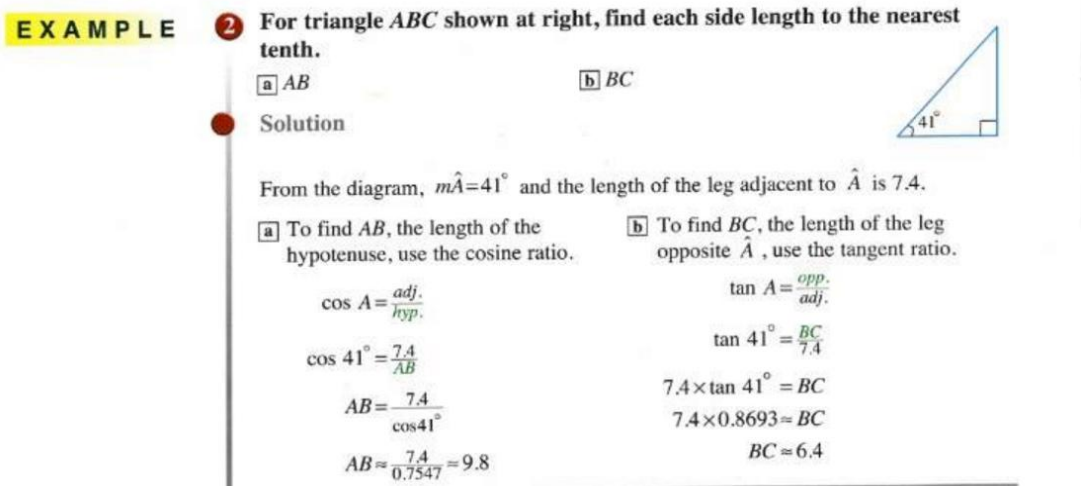


Figure 1. Chapter 1, Lesson Two, Page 12, Example 3

These findings are consistent with those of Zhao and Acosta-Tello (2016), who reported that erroneous examples can significantly influence students' procedural reasoning because learners often imitate demonstrated solution processes without critically evaluating their correctness. Although carefully designed incorrect examples may be used pedagogically to stimulate reflection and error analysis, unintended textbook errors are more likely to generate confusion and reinforce misconceptions.

A second example was identified in Chapter 8, Lesson One, Example 2, where students were asked to determine the side lengths of a triangle; however, the accompanying diagram did not contain the side labels or measurements referenced in the solution presented in Figure 2. The solution proceeded using variables such as (A), (B), and (C), despite these labels being absent from the figure. This discrepancy disrupts the coherence between visual and symbolic representations and may impair students' interpretation of the problem.



EXAMPLE 2 For triangle ABC shown at right, find each side length to the nearest tenth.

[a] AB [b] BC

Solution

From the diagram, $m\hat{A}=41^\circ$ and the length of the leg adjacent to $\hat{A}$ is 7.4.

[a] To find AB, the length of the hypotenuse, use the cosine ratio.

$\cos A=\frac{adj.}{hyp.}$

$\cos 41^\circ=\frac{7.4}{AB}$

$AB=\frac{7.4}{\cos 41^\circ}$

$AB\approx\frac{7.4}{0.7547}\approx 9.8$

[b] To find BC, the length of the leg opposite $\hat{A}$, use the tangent ratio.

$\tan A=\frac{opp.}{adj.}$

$\tan 41^\circ=\frac{BC}{7.4}$

$7.4\times\tan 41^\circ=BC$

$7.4\times 0.8693\approx BC$

$BC\approx 6.4$

Figure 2. Chapter 8, Lesson One, Page 326, Exercise 2

The absence of explicit labels and measurements can negatively affect students' spatial reasoning and their ability to coordinate multiple mathematical representations. Similar observations were reported by Arhin and Hokor (2021), who found that unclear mathematical representations frequently contribute to transformation and procedural errors. Likewise, Supardi et al. (2021) argued that students often experience difficulties with higher-order mathematical tasks when instructional examples fail to establish clear conceptual connections. These findings underscore the importance of rigorous mathematical verification during textbook development and review. Inaccurate examples not only diminish instructional quality but may also undermine students' confidence in the reliability of textbook content.

Conceptual and Instructional Deficiencies

The analysis also revealed instructional deficiencies in exercises that required students to apply concepts that had not been adequately introduced or explained in preceding lessons. A notable example occurred in Chapter 1, Lesson Three, Exercise 34, where students were expected to recognize a system with no solution despite the concept having received no prior explanation or guided practice.

This finding reflects a deficiency in pedagogical sequencing and instructional scaffolding. Effective mathematics instruction depends upon the gradual development of conceptual understanding; whereby new knowledge is constructed on previously established foundations. When students encounter unfamiliar concepts without sufficient preparation, they may experience cognitive overload, frustration, and reduced engagement with mathematical learning.

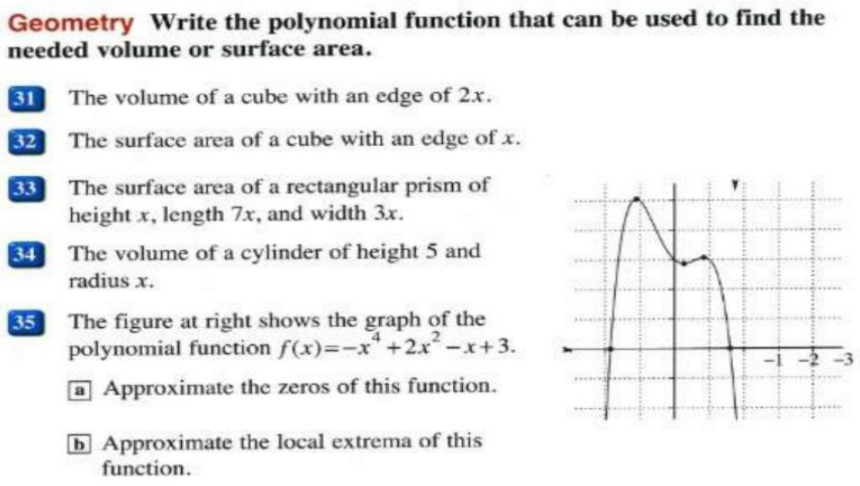
Previous research supports this interpretation. Saputra and Cesaria (2023) found that students' mathematical errors frequently stem from inadequate conceptual understanding and insufficient instructional support. Similarly, Xu (2023) emphasized that unresolved misunderstandings often accumulate over time and negatively affect subsequent mathematical performance.

From a constructivist perspective, meaningful learning requires learners to build new understandings through carefully structured experiences and progressive conceptual development. Exercises that exceed students' preparedness levels may therefore encourage memorization rather than reasoning-based understanding. Furthermore, such instructional gaps may place additional demands on teachers, who must compensate for incomplete textbook explanations during classroom instruction. As noted by Waswa et al. (2024), teachers in Iraqi secondary schools already face numerous instructional challenges, including limited educational resources and students' weak mathematical foundations. Consequently, deficiencies in textbook sequencing may further complicate the teaching and learning process.

Printing and Graphical Errors

Several printing and graphical errors were identified throughout the textbook. Although some of these errors may appear relatively minor, graphical accuracy is particularly important in mathematics because visual representations play a central role in students' understanding of abstract concepts.

One recurring issue involved the incorrect placement of the negative (x)-axis in coordinate graphs. For example, in Chapter 4, Lesson Two, Exercise 35, the negative (x)-axis was incorrectly positioned on the right side of the graph rather than on the left side, thereby violating standard Cartesian coordinate conventions (Figure 3). Similar errors were identified in the chapter on inverse functions.



Geometry **Write the polynomial function that can be used to find the needed volume or surface area.**

31 The volume of a cube with an edge of $2x$.

32 The surface area of a cube with an edge of x.

33 The surface area of a rectangular prism of height x, length $7x$, and width $3x$.

34 The volume of a cylinder of height 5 and radius x.

35 The figure at right shows the graph of the polynomial function $f(x)=-x^4+2x^2-x+3$.

[a] Approximate the zeros of this function.

[b] Approximate the local extrema of this function.

Figure 3. Chapter 4, Lesson Two, Page 158, Exercise 35

Such inaccuracies may contribute to misconceptions regarding coordinate systems and graphical interpretation. This concern is supported by Pomalato et al. (2020), who demonstrated that students frequently commit representational and procedural errors when mathematical information is presented inconsistently. Likewise, Gorgun and Botelho (2023) argued that misconceptions often emerge from the misinterpretation of symbols, representations, and instructional cues.

In addition to graphical inaccuracies, the textbook contained typographical and formatting errors, including misspelled mathematical terminology and incorrect variable

references. Although these errors were classified as minor, repeated exposure to inaccurate notation and terminology may reduce instructional clarity and weaken students' trust in the accuracy of educational materials.

The recurrence of printing and graphical errors suggests deficiencies in the textbook's editorial and quality-control procedures. These findings highlight the importance of involving mathematics specialists, editors, and graphical design reviewers throughout the textbook development process to ensure both mathematical and visual accuracy.

Translation and Language-Related Errors

Translation- and language-related issues constituted another important category of errors identified in the textbook. Several probability and combinatorics problems contained ambiguous, grammatically inaccurate, or informal English expressions that reduced the clarity of the mathematical tasks.

For instance, the probability problem presented in Chapter 6, Example 1 lacked grammatical coherence, making the intended meaning difficult to interpret. Similar linguistic problems were identified in Exercise 24 and Exercises 17–20, where unclear sentence structures reduced the precision of mathematical instructions. Such issues are particularly problematic because successful mathematical problem solving requires students to interpret linguistic and symbolic information simultaneously.

The importance of language in mathematics learning has been widely recognized in the literature. Xu (2023) argued that misunderstanding problem statements is a major source of student errors in secondary mathematics. Similarly, Waswa and Al-Kassab (2023a) reported that communication barriers and insufficient conceptual clarity are among the factors affecting mathematics learning in Iraq.

Translation quality is especially critical in bilingual and multilingual educational contexts. In such environments, linguistic ambiguity may become an additional obstacle beyond the inherent cognitive demands of the mathematical content. Consequently, the translation and adaptation of mathematics textbooks should involve collaboration between mathematics specialists and professional language editors to ensure both conceptual accuracy and linguistic precision.

Educational Implications

The findings of this study demonstrate that textbook quality plays a critical role in shaping students' mathematical learning experiences. Incorrectly solved examples, instructional deficiencies, graphical inaccuracies, and language-related problems may collectively contribute to misconceptions, diminished academic confidence, and weaker problem-solving performance. These findings are particularly relevant within the Iraqi educational context, where mathematics education continues to face challenges associated with limited instructional resources and curriculum implementation (Serhang & Karim, 2024).

More broadly, the results suggest that textbook evaluation procedures require substantial strengthening throughout the curriculum development process. Educational authorities and curriculum developers should establish systematic review mechanisms involving mathematics educators, curriculum specialists, language experts, editors, and graphic designers prior to

textbook publication and distribution. Such multidisciplinary review processes would help ensure mathematical accuracy, conceptual coherence, linguistic clarity, and visual consistency.

In addition, periodic textbook evaluation should be institutionalized to facilitate the continuous identification and correction of errors. Ongoing review processes would contribute to improving instructional quality and ensuring that curriculum materials remain aligned with educational objectives and students' cognitive and developmental needs. Overall, the findings underscore the importance of maintaining high standards of accuracy, coherence, and pedagogical quality in mathematics textbooks, particularly in educational contexts where textbooks serve as the primary instructional resource for both teachers and students.

Conclusion

This study examined the accuracy and instructional quality of the Grade 10 mathematics textbook used in secondary schools in the Kurdistan Region of Iraq during the 2015–2025 curriculum implementation period. Using a qualitative document analysis approach, the study identified eleven errors, comprising ten major errors and one minor error, which were classified into four categories: incorrectly solved examples, conceptual and instructional deficiencies, printing and graphical errors, and translation- and language-related inaccuracies. The findings indicate that these errors are not merely editorial oversights; rather, they represent issues that may compromise the quality of mathematics instruction and learning. Several of the identified errors involved inconsistencies between mathematical procedures and graphical representations, incomplete conceptual explanations, inaccurate visual information, and ambiguous language, all of which may negatively affect students' understanding of mathematical concepts and their ability to apply mathematical reasoning effectively.

The analysis further suggests that textbook-related errors may have important educational consequences because textbooks serve as a primary source of mathematical knowledge and instructional guidance in many classrooms. Incorrectly solved examples may reinforce procedural misconceptions, while conceptual gaps can hinder the development of coherent mathematical understanding. Similarly, graphical inaccuracies may lead to misinterpretations of mathematical representations, and language-related problems may increase the cognitive demands placed on students when interpreting mathematical tasks. These findings highlight the critical role of textbook quality in supporting conceptual understanding, problem-solving performance, and meaningful engagement with mathematics. They also emphasize the importance of ensuring consistency among symbolic, graphical, and verbal representations of mathematical ideas to facilitate effective learning.

The study underscores the need for rigorous textbook evaluation and quality assurance procedures throughout the processes of curriculum development, textbook production, and revision. Comprehensive review mechanisms involving mathematics educators, curriculum specialists, graphic designers, and language experts should be established to ensure the mathematical accuracy, conceptual coherence, linguistic clarity, and pedagogical effectiveness of instructional materials before their implementation in schools. In addition, periodic textbook evaluations should be institutionalized to support the timely identification and correction of errors and to maintain alignment between instructional materials and curricular objectives. By

providing empirical evidence regarding textbook-related instructional issues, this study contributes to the literature on mathematics textbook evaluation and offers practical recommendations for curriculum developers, textbook authors, teachers, and policymakers seeking to improve mathematics education in the Kurdistan Region of Iraq and other comparable educational contexts. Future research may extend this work by investigating how textbook-related errors influence classroom instruction, teachers' pedagogical decisions, and students' mathematical learning outcomes in practice.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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