

Evaluating the third-grade intermediate mathematics textbook in light of qualitative standards (A case study in the Republic of Iraq)

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ABSTRACT:

The third-grade intermediate mathematics textbook in the Republic of Iraq is studied according to qualitative standards. The qualitative research was based on the nature of the data, applied approach in its purpose, and descriptive documentary approach to the data collection. The study was therefore documentary content analysis. The research population consisted of the entire content of the Iraqi third-grade intermediate mathematics textbook (and since there is a whole textbook to analyze, the sample and the data set are identical). The measurement tool used was a content-standards checklist for the third-grade intermediate mathematics textbook according to the National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics. The checklist covered 10 principles: number and operations, algebra, geometry, measurement, data analysis and probability, problem solving, reasoning and proof, communication, connections and representation. Content analysis was used to process the data. The textbook was mainly on algebraic concepts and problem solving and other aspects of geometry, measurement, and statistics were only a fraction of the coverage. However, deeper skills (e.g., reasoning, systematic proof, effective mathematical communication and the use of various representations) need to be developed.

Keywords: evaluation; mathematics textbook; qualitative standards; third-grade intermediate; Republic of Iraq

introduction

The evaluation of mathematics textbooks at various educational levels is one of the critical steps to improve the quality of mathematics education and meet national educational needs. In Iraq, this is especially important as the quality

of textbooks determines students' performance and at a national level (Jazairi et al., 2019). Because mathematics is necessary for logical and analytical thinking and deep understanding of the concept of mathematics, textbook evaluation is a natural way to identify the strengths and

weaknesses in educational content (Baradaran et al., 2018). Examining the third-grade intermediate mathematics textbook in Iraq is therefore crucial for improving educational quality and providing students the content that is in line with the needs and educational needs of students and the curriculum developments in the present day. There are many issues in Iraqi education concerning textbook content and teaching mathematics, which directly impact students' understanding of mathematical concepts. So far studies have indicated that the third-grade intermediate maths textbook contains materials that may not be compatible with students' learning capacity (Ali, 2020). The most important issue in Iraqi mathematics textbooks is the lack of interactive activities and real-life scenarios for students to apply what they've been taught to life experiences. Also in the textbook are not diagrams and visual aids which could help students grasp the concepts better (Hassan, 2019). Visual aids and interactive activities can help students understand and have motivation to engage with the material in school. Also, technology is not being integrated into the education process. Moreover, most of the classrooms have no digital tools to help students learn mathematics through a fast-paced technological environment (Abdallah, 2021; Al-Hashimi, 2018). This traditional orientation limits engagement with mathematics by participants in order to interact with mathematics effectively. The textbook also does not correspond well to the culture and local needs of Iraqi students in that it contains few examples and exercises that are relevant to the life of Iraqi students. Education experts believe that the content that is closer to students' everyday life motivates them to learn mathematics and use it on the ground (Mohammed, 2020). So the language and content of this textbook needs to be updated to better suit the Iraqi society and culture. Another challenge in the Iraqi educational system is the complexity of mathematics in textbooks, which are often much more complex than the students' cognitive ability (Al-Salman, 2018). This complexity and the traditional teaching approach can obstruct

students' conceptual ability as well. Research shows mathematics in textbooks are not always visual to the students and are often not as well-developed in terms of teaching techniques in real-life applications (Ahmed, 2020). As well, technology is still not used as a core element of education and so the students are not exposed to learning in the subject (Hussein, 2019). Today we need to incorporate digital tools into math education and I think it can make learning more vivid and more active as students are not getting a good opportunity to do that and how they can learn, in the case of a bad school (with teaching methods that are not effective). Contextual alignment is also crucial. Many textbooks do not capture the socio-cultural outlook of Iraqi students or their everyday life (Al-Taie, 2021). This mismatch reduces the relevance of the content and also decreases students' motivation to learn. There are a number of studies that found low achievement in mathematics which may be attributed to the school textbooks being deficient for activities and content. So far, the researcher has not performed a comprehensive study on the third-grade intermediate mathematics textbook according to broad qualitative standards. The research problem is then defined by the need to assess the textbook according to the highest quality criteria. The main research question is: Does the Iraqi third-grade intermediate mathematics textbook meet the highest qualitative requirements?

2. Literature Review and Previous Studies

Algebra begins with general methods for solving equations and emphasises relationships between quantities, functions, symbolic representations, and change. Its symbolic language allows for compact representation of complex ideas and efficient analysis of relationships. It has applications in physics, networks, population models, and statistics. Algebra also involves abstract structures and extends students' experience by applying its principles to problem solving. It is a basic part of the mathematics curriculum and a type of algebraic competence necessary for professional life and further study due to its close relationship with geometry and

data analysis (Sun et al., 2023). Algebra should be open to all students.

2.1.3. Geometry

The course introduces students to geometric shapes and structures. It teaches students how to analyse the properties and relations of these objects using geometry. Spatial visualisation is an important aspect of geometric thinking - the construction and representation of mental images of two- and three-dimensional objects and the ability to understand them from different perspectives. Geometry is also a natural area for developing reasoning and justification leading to proof at the intermediate and secondary stages. Geometric modelling and spatial reasoning help students to interpret and describe physical environments and solve problems (Meserve,

2.1.4. Measurement

Measurement is assigning a number to a feature of an object. For example, the length of a pencil. At higher levels of complexity, it is assigning a number to an attribute in a given context, as in the consumer price index. This standard is about understanding what can be measured, knowing the units and processes used in measurement and using measurement tools, techniques and formulas in different situations (Fréney-Mandy, 2000).

Measurement is practical and common in everyday life and is important throughout the curriculum from childhood through to secondary school. It provides opportunities to learn and apply other areas of mathematics such as numerical operations, geometric notions, statistical ideas and functions. These connections are not only in mathematics but also in social science, arts and physical education (Fréney-Mandy, 2000).

2.1.5. Data Analysis and Probability

The Data Analysis and Probability standard is designed to have students be able to formulate questions that can be answered by data, to gather, organise and represent data in appropriate ways, and to use elementary methods of analysis and inference to reach conclusions. It comprises

2014). Geometric ideas are useful in describing and solving problems in other parts of mathematics and in real life situations. Therefore, geometry should be combined with other fields wherever possible. Graphs and scatterplots can help us to understand data and geometric visualisation helps to understand area and fractions. Coordinates are the bridge between geometry and algebra and are used for creating diagrams, route planning, map use and design. Students can actively interact with geometric ideas using concrete models, maps and dynamic geometry software. Carefully designed tasks, appropriate tools and teacher guidance allow students to formulate and investigate geometric conjectures, learn precise reasoning and construct understanding from informal to formal thinking (van Hiele, 1986).

elementary notions of probability and relation to statistics (Mitzenmacher & Upfal, 2017). Data are of great importance in scientific, economic, political, and daily decision-making. It is important to be aware that statistics can be misused to sway public opinion. Citizens should be acquainted with data analysis and probability to be informed and critical citizens (Rice & Rice, 2007).

2.1.6. Problem Solving

Problem solving is the process of working through difficulties when you don't know the solution in advance. Students call on their knowledge, and often develop new mathematical understanding in the process, to find a solution. Not only is problem solving a goal of mathematics learning, it is also its principal vehicle. Students should be given multiple opportunities to formulate, confront and resolve complex issues and to reflect on their thinking methods (Rohmah & Sutiarso, 2017). Problem solving helps students develop strategies for thinking, habits of mind, curiosity, and confidence in strange situations. These skills are used not only in the mathematics classroom but also in everyday life and the workplace where effective problem solving is of great value (Rohmah & Sutiarso, 2017).

2.1.7. Reasoning and Proof Mathematical reasoning and proof are powerful sources of insight into many phenomena. Analytical thinkers and reasoners tend to see patterns, structures, and systems in both real-world situations and symbolic things. They ask whether the patterns are random or caused by certain things, make guesses and explain them. Mathematical proof is a formal way of expressing certain kinds of reasoning and justification (Ubuz, 2007).

Reasoning and proofs are not taught only through a unit on logic, or through performing proofs using geometry. Proof is difficult even for university students and can be especially hard for secondary students whose experience is mostly limited to one geometry textbook, which narrows their perspective (Moore, 1994).

2.1.8. Communication

Communication is an integral part of learning and doing mathematics as it provides a way of exchanging ideas and understanding. Communication makes ideas objects of reflection, discussion, revision and refinement . Communication also helps to make meaning and makes ideas available to others . Students learn to communicate their reasoning clearly and persuasively . (Asking students to think and reason mathematically and to communicate their results orally or in writing .) Hearing others explain their thinking expands their understanding and helps them develop a language to talk about mathematical ideas (Hatano & Inagaki, 1991).

When students are helped to speak, write, read and listen to mathematics, they gain a double benefit: they learn mathematics and they learn mathematical communication itself. Mathematical communication requires accuracy, encouragement and opportunities to use language for a purpose (Tong et al., 2021).

2.1.9. Connections

As students relate mathematical ideas to one another, their understanding becomes richer and more lasting. They are able to identify links

between mathematical topics and contexts that relate mathematics to other disciplines and to their interests and experiences. Teaching that emphasises connections not only helps students to learn mathematics, but also to learn how to use mathematical ideas (Pambudi et al., 2020).

Mathematics is not a set of isolated fields, although it is sometimes presented that way; it is a unified science. When viewed as a unified whole, it becomes clear that the study of connections within mathematics across grade levels is needed. Teachers need to know the needs of their students, what the students have already learned and what they will learn in the future. Learning involves making connections, not repeating the same thing endlessly, and using what you already know to support your new ideas (Hatisaru, 2023).

2.1.10. Representation

The forms of expression of mathematical ideas are fundamental to the understanding and use of them by people. The difficulty of doing multiplication with Roman numerals as opposed to the Hindu-Arabic decimal notation shows the importance of representation. Many of the representations that we now take for granted—decimal and binary numbers, fractions, algebraic equations and expressions, graphs, diagrams, data tables—are cultural developments. Multiple representations are given to students to represent the concepts they are learning. This gives students a broader set of tools for mathematical thinking (Jitendra et al., 2016). Representations are essential for helping students understand mathematical concepts and relationships, communicate methods and reasoning, make connections among related ideas, and apply mathematics to real-world situations through modelling. Digital technology offers new modes of representation that deserve more pedagogical attention (Gates, 2017).

2.2. Research Background

Research related to the evaluation of mathematics textbooks in light of qualitative standards is summarized in Table 1.

Table 1. Summary of Previous Studies

Author (year)	Research focus	Method / sample	Main findings
Eskandari et al. (2021)	Content analysis of the probability section in lower-secondary mathematics textbooks according to interpretations of probability	Categorical content analysis; Grades 7–9 textbooks	76% of exercises were based on the classical interpretation; only 5% were frequentist; severe weakness in connecting interpretations.
Tayebi et al. (2019)	Content analysis of Grade 6 mathematics according to cognitive-demand levels	Content analysis based on the Stein and Smith model	Most exercises addressed higher cognitive levels; limited attention was given to memorization.
Rafipour & Molaei (2018)	Analysis of lower-secondary mathematics exercises through a modeling perspective	Analysis of 912 exercises	Context-free exercises predominated; realistic modeling problems were absent; Grade 9 had the weakest connection to the real world.
Karami et al. (2011)	Content analysis of Mathematics 1 according to William Roney and Bloom	Content analysis	Texts and pictures were active; however, 81% of exercises were at the comprehension level, with limited attention to higher cognitive levels.
Moqaddam & Sohrabi (2010)	Examination of cultural components in elementary mathematics textbooks	Content analysis	Cultural, social, and identity-related themes—including religion, nation, and equality—were reflected in problems.
Abbaszadeh et al. (2025)	Design of integrated content for a Grade 3 elementary mathematics textbook and evaluation of its effect on learning	Mixed methods; teachers and students	Deeper integrated learning and a positive effect of content integration on learning.
Siregar et al. (2024)	Critical content analysis of writing materials in Indonesian high-school English textbooks	Qualitative content analysis	Writing genres were represented, with emphasis on intensive and extensive writing tasks.

The review of previous studies indicates that the evaluation of mathematics textbooks in many countries has focused mainly on content analysis based on educational standards, cognitive levels, connections to the real world, teaching-learning approaches, and qualitative indicators. The results of Arabic and regional studies indicate the high frequency of procedural exercises, the lack of focus on higher cognitive levels, and the imbalance in coverage with limited treatment of modelling, probability and integrated approaches.

International research also confirms the importance of qualitative standards, structural coherence, spatial contiguity and the role of textbooks in deep learning and self-regulation. Al-Tamimi (2017) found a relatively high degree of alignment between the content of mathematics textbooks and international standards, but teachers perceived different levels of achievement of those standards in practice. The existence of such a gap between theory and practice indicates the significance of evaluating the Iraqi third grade intermediate math textbook on qualitative standards to identify its strengths

and weaknesses and to support curriculum development.

3. Methodology

3.1. Research Design

The data is qualitative in nature, applied in purpose and descriptive and documentary in method of data collection. Therefore the research method is qualitative documentary approach with content analysis .

3.2. Population and Sample

The research population consisted of the complete content of the Iraqi third-grade intermediate mathematics textbook. Because the entire textbook was analyzed comprehensively, the statistical population and the sample were identical.

3.3. Instrument

The instrument was a content-standards checklist based on the NCTM publication Principles and Standards for School Mathematics. The checklist comprised ten principles and standards: number and operations, algebra, geometry, measurement, data analysis and probability, problem solving, reasoning and proof, communication, connections, and representation.

3.4. Data-Analysis Procedures

a. Defining the purpose and research questions

At this stage, the researcher defined the purpose of the study and formulated questions designed to reveal the underlying content and patterns in the data.

b. Collecting the data

The data consisted of the textbook's written content, exercises, examples, diagrams, and other relevant elements. The researcher ensured that the collected material was directly related to the purpose of the study.

c. Coding the data

The researcher identified and coded the content and patterns in the data. Coding could be performed manually or with qualitative-analysis software.

d. Analyzing and interpreting the data

After coding, the researcher analyzed and interpreted the data by identifying recurring patterns, meanings, and content categories.

e. Presenting the results

Finally, the researcher presented the results in an organized and systematic report that provided accurate descriptions of the identified content and patterns.

4. Results and Discussion

The following results summarize the representation of the ten NCTM principles in the Iraqi third-grade intermediate mathematics textbook. Frequencies and percentages are reproduced as reported in the original manuscript.

Table 2. Representation of NCTM Principles in the Textbook

NCTM principle	Status in the Iraqi third-grade intermediate textbook	Frequency	Percentage
Number and Operations	Emphasis on number, computation, and more complex numerical problems; coverage remains mostly basic.	35	10.0%
Algebra	The most prominent domain: notation, functions, equations, and modeling; consistent with the emphasis reported in previous studies.	55	15.7%
Geometry	Includes analytic geometry and geometric laws, but is not the principal focus; spatial and visual aspects receive less attention.	40	11.4%

Measurement	Includes area, volume, and practical applications, but dedicated resources and activities are limited.	20	5.7%
Data Analysis and Probability	Very limited; includes some statistical exercises and basic probability but lacks an integrated framework.	20	5.7%
Problem Solving	A central axis of the textbook; open and problem-based questions promote critical thinking.	45	12.9%
Reasoning and Proof	Some laws and simple proofs with conceptual analysis, but treatment is not extensive.	20	5.7%
Communication	Some exercises include solution presentation and group discussion, but formal documentation and oral expression are less visible.	18	5.1%
Connections	Some links exist among numerical, geometric, and algebraic topics, but they are not systematically organized.	18	5.1%
Representation	Equations, diagrams, and geometric representations are used, but clarity and variety are moderate.	19	5.4%

4.1. Number and Operations

The number and operations principle was represented in 35 content units, which constituted 10% of the textbook. The book is mainly basic but some numerical and computational ideas are used, such as composite functions, roots and algebraic fractions. The analysis indicates that the focus is on algebra and problem solving, not extending number structure, more advanced numerical reasoning or number sense.

4.2. Algebra

Algebra is the backbone of the text. The book covers equations, quadratic expressions, functions, polynomial terms, algebraic identities, domain and range and graphical analysis. 55 content units, accounting for the 15.7% of the total content, the highest rate among the ten principles. The strong emphasis on this area is consistent with the traditional approach to mathematics teaching in Iraq and is largely consistent with NCTM standards, especially in regard to symbolic notation and equation solving. The algebraic modelling in the textbook also demonstrates reasonable coherence of content.

4.3. Geometry

Geometry represented 40 content units or 11.4% of the total. The textbook is paying attention to

analytic geometry, the distance between two points, the coordinate system and vectors. But geometry is not a major organising theme. In contrast to the visual and intuitive aspects, spatial reasoning and applied geometric problems are comparatively limited. A clear weakness in this area is the lack of diagrams and picture tools.

4.4. Measurement

Measurement was represented by 20 content units, which corresponded to 5.7% of the total. Topics include the area of simple figures, the volume of solids, but there is little further treatment of units of measurement, precision, or applications in the other sciences. Therefore, the textbook offers limited opportunities for students to develop practical measurement skills.

4.5. Data Analysis and Probability

Data analysis and probability appeared in 20 content units or 5.7 percent of the textbook. The treatment is limited and introductory, addressing basic concepts such as classical probability, mean, median and simple tables. There are few opportunities to see real data or to connect statistical ideas with everyday life. However, there is a clear disadvantage in the implementation of this principle – lack of detailed graphs and sophisticated statistical/probabilistic models.

4.6. Problem Solving

The textbook has strengths in problem solving. 45 content units (12.9 percent) were dedicated to tasks that encouraged the use of multiple mathematical concepts and the application of critical thinking. The exercises are open-ended question type, multi-step task and some real life situation. This emphasis is consistent with NCTM goals for developing independent mathematical thinkers and problem solvers.

4.7. Reasoning and Proof

Reasoning and proof took up 20 content units, or 5.7%. Some chapters contain reasoning and proof, but usually only in the form of simple proofs of identities or elementary geometric theorems. Few multi-step proofs or extended chances to develop deductive and inductive reasoning. This constraint could be a barrier to students' understanding of the logical structure of mathematical concepts.

4.8. Communication

Communication was represented by 18 content units or 5.1%. The text occasionally asks students to provide solutions or to discuss solutions in groups, but there are few structured prompts for documenting reasoning, explaining solution steps, or orally expressing mathematical ideas. The limited number of tasks for explanation and discussion may lead to neglect of communication as a mathematical competency.

4.9. Connections

Connections were represented by 18 content units, or 5.1%. The textbook contains some relationships among numerical, geometric, and algebraic topics and occasionally presents applications of functions and geometry in scientific contexts. Nevertheless, these links are often superficial and scattered rather than systematically planned. The lack of coherent connections may prevent students from viewing mathematics as an integrated discipline and from relating it to real life.

4.10. Representation

Representation was addressed in 19 content units, or 5.4%. The textbook uses equations, diagrams, coordinate systems, functions, and vector representations, which indicates acceptable performance in this area. However, the variety of representations is moderate, and contemporary tools such as dynamic visualizations are not used extensively. Greater clarity, flexibility, and variety in representations could support deeper and more durable understanding.

5. Findings and Conclusions: The analysis of the Iraqi third grade intermediate mathematics textbook shows that all the ten NCTM principles are present but with different frequencies and emphasis. The most important domain is algebra, 55 content units (15,7 %).

The emphasis is consistent with the emphasis of the textbook on quadratic formulas, functions, algebraic identities and graphs, which are the major topics at this level of education. Next is problem solving with 45 units (12.9%).

This shows that the textbook is aware of the importance of applying mathematical knowledge to complex and practical tasks. Geometry is 40 units (11.4 percent) and number and operations is 35 units (10 percent). These domains are the primary conceptual and procedural framework of the textbook. Next are Measurement and data analysis/probability, 20 units each (approx. 5.7%). Further development in both areas is necessary for better measurement and analysis of real data. The other principles, reasoning and proof, communication, connections, and representation, are 18 to 20 units each, or about 5 to 5.7 percent of the total, and are generally limited or incidental in nature. In particular, mathematical communication and the links between mathematical concepts and other scientific fields should be paid more attention, as these have direct implications on the students' ability to apply mathematics in real life and future scientific careers.

Overall the textbook tries to stress algebra and problem solving while giving partial coverage of geometry, measurement and statistics. But deeper competencies such as deep reasoning, coherent proof, effective mathematical communication and the use of multiple representations need much more development. The findings are in line with local and international research that mathematics textbooks tend to emphasise algebraic procedures and exercises. For example, Jiang and Li (2023) stated that Chinese students rely heavily on examples and exercises in the textbook, and Al-Tamimi (2017) showed that algebra and data analysis are given high priority in Iraqi textbooks. This indicates a certain correspondence between the emphasis of content in the current textbook and the broader trends in different educational systems. The results of the present study, however, differ from some previous studies. The Iraqi textbook included probability in a limited scope. This finding is consistent with the findings of Eskandari et al. (2021) who found that the probability sections of Iranian mathematics textbooks were mainly based on the classical interpretation and did not show diversity. Some other studies highlighted an emphasis on higher cognitive levels.

However, the current textbook needs further analysis to see whether the problem-solving exercises are really open and cognitively demanding or procedural.

The present results are in line with some studies that have shown that the exercises in Iranian textbooks pay little attention to realistic modelling and more to abstract algebraic problems in terms of modelling and real-world connections.

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In their visual representation, Woollacott et al. (2024) noted that “where diagrams and images are placed within textbook text has a significant impact on learning.” This is not adequately covered in the current textbook and is an important area for future development.

6. Recommendations

- Applying adjunct studies to classify all the exercises in the third grade of the Iraqi intermediate book of mathematics according to Bloom's taxonomy or the framework of Stein and Smith.
- Use explicit criteria for clarity, contiguity and pedagogical function to evaluate the quality of the textbook's visual representations, including diagrams, graphs, tables and spatial layouts.
- Increase the proportion of authentic, situated and modelling-based tasks linking mathematics to the everyday lives of Iraqi students and to other science disciplines.
- Increase the emphasis on data analysis and probability using real data sets, statistical investigations, multiple representations and applications to everyday decision making.
- Give more opportunities for mathematical communication: written explanations, oral presentations, collaborative discussion and explicit justification of methods used to solve problems.
- Extend reasoning and proof beyond isolated geometric procedures using conjecture, explanation, counterexample, induction, and multi-step deductive arguments.
- Results from future textbook evaluations will be used to rebalance the ten NCTM principles and to support evidence-based revision of the mathematics curriculum.

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