

Evaluation of Cambridge Math Series for Grades 4 & 8 in Oman using TIMSS 2019 Standards

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1. Introduction

1.1 Introduce the Problem

Educational systems worldwide prioritize science and mathematics education due to their essential role in meeting societal needs, labor market demands, and supporting decision-making and innovation in everyday life. In Oman, this focus has led to developing and refining science and mathematics curricula, emphasizing knowledge-building and technology adoption. This vision is outlined in Oman's Philosophy of Education, and it is reinforced by the National Education Strategy and Vision 2040, both of which advocate for scientific research education and the development of innovation skills.

Reflecting these principles, the Ministry of Education in Oman has implemented curricula such as the Cambridge series, which emphasizes inquiry-based learning and problem-solving skills. Evaluating such curricula requires effective assessment models; therefore, various frameworks, including the Tyler, Metfessel-Michael, and Stufflebeam's CIPP (Context, Input, Process, Product) model, are widely used. This study employs the CIPP model by Stufflebeam, a widely recognized framework that supports experts in making informed decisions about planning, structuring, and implementing educational programs (Hunkins, 2018; Uşun, 2016; Erden, 1998).

This research is particularly important as it examines the alignment of Oman's Cambridge Mathematics series with international standards, specifically the TIMSS (2019). Aligning curricula with such benchmarks is crucial for preparing students to compete in a global context and for realizing Oman's Vision 2040 goals of fostering a knowledge-based and innovative society. Building on past studies that have applied the CIPP model to curriculum evaluation, this study offers unique insights by focusing on Oman's specific curriculum and its adherence to TIMSS standards. This provides a comprehensive perspective on how well the curriculum prepares students for both national and international expectations.

The study hypothesizes that the Cambridge Mathematics series aligns with the TIMSS (2019) standards, with a secondary objective of assessing the curriculum's effectiveness in fostering cognitive skills. Grounded in educational theories that highlight inquiry-based and problem-solving approaches, the study's mixed-method research design (content analysis and CIPP evaluation) directly addresses these objectives. The results contribute theoretically by validating the CIPP model's applicability in evaluating curricula for international alignment and provide practical insights for curriculum developers and policymakers. This can help enhance the curriculum's quality, ensuring it meets both Oman's educational goals and international standards.

1.2 Explore Importance of the Problem

Analysis of Omani students' performance in TIMSS tests reveals consistently low scores in the years 2007, 2011, and 2015, with Oman ranking second to last globally in 2011 with an average score of 366 and in 2015 with 403 points, both below the global average of 500 points (Abdul Karim et al., 2023; Mullis et al., 2016). Although there was a slight improvement in 2019, with 4th graders scoring 435 points compared to 431 points in the previous cycle, the scores remain below the global average. 8th graders also maintained similar performance, scoring 457 points in 2019 compared to 455 in 2015 (Ministry of Education, 2023). Despite adopting the Cambridge series in the 2018-2017 academic year, results have not significantly improved, indicating potential issues in curriculum content or implementation (National Report, Ministry of Education, 2020). Studies have recommended revising the content of mathematics textbooks to better meet TIMSS requirements (Jehwari & Kharoosi, 2010; Alayan & Mazrouei, 2020), and there are concerns about the suitability of the Cambridge series for the Omani educational context (Ministry of Education, 2018). Feedback from specialists highlighted several issues with the Cambridge curriculum, including excessive details, insufficient allotted time, and lack of alignment with TIMSS standards (Al Balushi, 2019). This study underscores the necessity of evaluating the Cambridge series for grades 4 and 8 to enhance Omani students' readiness for TIMSS assessments and improve overall academic achievement. In summary, aligning Oman's mathematics curriculum with TIMSS standards is vital for improving educational quality, supporting national goals, enhancing workforce readiness, and promoting equity in education.

1.3 Describe Relevant Scholarship

Importance of the Study

The importance of this study lies in its focus on the new mathematics curricula in Oman, utilizing the CIPP (Context, Input, Process, Product) evaluation model. This model's four components will assist curriculum specialists in creating comprehensive development plans for enhancing mathematics curricula in alignment with TIMSS (2019) standards.

Theoretical Importance:

- The study aims to verify how well the content of the Cambridge Mathematics series currently used in Oman aligns with the standards and indicators outlined in the TIMSS (2019) mathematics learning assessment framework. It will reveal the feasibility of these curricula and their appropriateness for the Omani educational environment.
- It seeks to bridge the theoretical gap due to the scarcity of research evaluating the extent to which the Cambridge Mathematics series in Oman adheres to the content areas, major topics, and indicators included in the TIMSS (2019) assessment framework.
- This study will provide a significant contribution to the Omani national library, as well as the Gulf and Arab libraries, particularly during a time when Oman is striving to advance education as a strategic sector. Mathematics is especially vital as it lays the foundation for training future scholars capable of competing on regional and global levels.

Practical Importance:

- The findings of this study may aid specialists in the General Directorate of Curriculum Development in implementing enhancements to the current curriculum content, whether through additions or deletions, to ensure alignment with TIMSS standards.

Logical Continuity Between Previous and Present Work

This study builds on prior research that has explored curriculum evaluation through various models, including CIPP. By specifically targeting the Cambridge Mathematics series in Oman, it provides a focused analysis of its alignment with international benchmarks, addressing a gap identified in previous studies. The research emphasizes the importance of aligning local curricula with global standards, fostering an educational environment that equips students with the necessary skills for the future.

Through this study, the logical continuity is established by both recognizing the contributions of earlier research and extending that foundation to the specific context of Oman. By doing so, it aims to make the problem of curriculum alignment comprehensible to a wider professional audience, ensuring clarity and accessibility for specialists and educators alike. This approach highlights the necessity of rigorous evaluation to promote effective teaching and learning practices, ultimately benefiting the broader educational landscape.

1.4 State Hypotheses and Their Correspondence to Research Design

This research design methodically examines the alignment of Cambridge mathematics textbooks for 4th and 8th grades in Oman with TIMSS 2019 standards by analyzing specific content and cognitive dimensions. The study measures the extent to which these textbooks incorporate TIMSS standards in areas such as numbers, geometry, algebra, data, and probability. Additionally, it evaluates the cognitive dimensions (knowledge, application, reasoning) from the perspectives of teachers and supervisors. By employing a detailed content analysis, supported by insights from educational practitioners, the research can derive empirical evidence on whether the textbooks meet international benchmarks, thus providing a robust framework for evaluating their effectiveness.

Statistical analyses, including hypothesis testing, are used to identify significant differences based on variables such as experience and job role. This approach ensures that inferences drawn from the data are reliable and actionable. For example, the study hypothesizes no significant differences in the inclusion of cognitive dimensions based on teachers' experience or job roles, allowing for focused examination of potential discrepancies. The comprehensive nature of this research design enables it to yield credible estimates and insights, guiding curriculum enhancement efforts to improve student readiness for international assessments.

2. Literature Review

The significance of this study is multifaceted, encompassing both theoretical and practical aspects.

Theoretical Importance:

1. This study investigates the alignment of the content of Cambridge mathematics textbooks currently used in Oman with the standards and indicators outlined in the TIMSS 2019 evaluation framework. The aim is to assess the effectiveness and suitability of these curricula for the Omani educational environment.
2. It identifies obstacles that hinder the implementation of the Cambridge mathematics curriculum in Oman. Previous studies, such as those by Alayan and Mazrouei (2020), highlight various challenges related to content, the learning environment, and teacher preparedness.
3. This research addresses the theoretical gap due to the scarcity of studies evaluating the Cambridge mathematics textbooks in Oman against TIMSS 2019 standards in key content areas and topics.
4. The study contributes valuable knowledge to the Omani national library and the wider Gulf and Arab libraries. Given Oman's strategic focus on improving education and the critical role of mathematics in training future scientists, this research is timely and significant.

Practical Importance:

This study may assist specialists in the General Directorate for Curriculum Development in improving the current curriculum, aligning it more closely with TIMSS standards through content adjustments.

Study Boundaries:

- Subject Boundaries: The study involves preparing a list of TIMSS 2019 requirements to analyze the content of Cambridge mathematics textbooks for the 4th and 8th grades, focusing on content (numbers, algebra, geometry, measurement, data processing) and cognitive processes (knowledge, application, reasoning).
- Human Boundaries: The study is limited to a sample of mathematics supervisors and teachers for the 4th and 8th grades in public schools under the General Directorate of Education in Muscat.
- Spatial and Temporal Boundaries: The study will be conducted in schools under the General Directorate of Education in Muscat, Oman, during the second semester of the 2023-2024 academic year.

Study Terms:

- Basic Education System in Oman: Unified education provided by the state for all children in Oman and residents of school age, lasting ten years and divided into two cycles: the first cycle (grades 1 to 4) and the second cycle (grades 5 to 10). Successful students progress to post-basic education, lasting two academic years (Education Council, 2014).
- Standards: Defined as the set of specifications, conditions, and characteristics that determine what should be included in performance at the enabling and initiation stages. They serve as criteria for selecting specific topics or content (Al-Eisa, 2023; Saada & Ibrahim, 2004).
- TIMSS: The Trends in International Mathematics and Science Study, which includes content and cognitive dimensions to assess students' mathematics performance in grades 4 and 8. It is a global study evaluating students' mathematics achievement, focusing on curriculum effectiveness and teaching methods, conducted under the International Association for the Evaluation of Educational Achievement (IEA) every four years.
- TIMSS 2019 Standards Requirements: The set of benchmark specifications established by the International Association for the Evaluation of Educational Achievement for the TIMSS 2019 study, used by many countries to measure student achievement levels and expected to be included in the mathematics textbooks for grades 4 and 8 (Education Council, 2020).
- Curriculum Evaluation: The process of judging the extent to which educational objectives are achieved, identifying deficiencies, selecting methods and activities to achieve these goals, and evaluating them considering intended outcomes (Abdul Noor, 1977).
- Curriculum Content: Defined by Rushdie Taima as the information, facts, ideas, and concepts conveyed through specific symbols within a structured system to achieve a particular goal (Taima, 2004). In this study, it refers to all content in the mathematics textbooks for grades 4 and 8, including topics, activities, and exercises.

Summary, Based on the theoretical background and research problem discussed in this chapter, four study objectives have been outlined, along with corresponding questions and hypotheses, limitations, and definitions. Given that Oman has been applying the Cambridge mathematics curriculum for over five years, the current study will evaluate the content of these textbooks for grades 4 and 8 in light of TIMSS 2019 standards, considering the CIPP evaluation model.

3. Method

To achieve the objectives of the study and answer the research questions, a mixed-methods approach (quantitative and qualitative) was employed to obtain comprehensive data and present it clearly. Data collection, analysis, and interpretation for both methods were conducted in a single study (Abu Allam, 2021, p. 153). This approach is most suitable and widely used for such studies as it involves numbers and characteristics of certain phenomena related to educational practices or standards, and the inclusion rates of these standards in the curricula. This method is based on a set of research procedures that involve collecting facts and data, classifying, processing, analyzing them fully and accurately, extracting their significance, and arriving at conclusions or generalizations about the phenomenon under study.

Several tools were used to collect data that contribute to answering the study questions and achieving its objectives. The first tool was a content analysis form for the mathematics textbooks of the 4th and 8th grades. The second tool was a questionnaire for teachers and supervisors, including TIMSS 2019 standards that should be incorporated into the content of the textbooks in the study sample.

3.1 Community

The term "community" refers to all individuals, elements, objects, numbers, and measurements that share observable common characteristics and are intended for analysis (Abu Allam, 2004, p. 157). The study population typically consists of two groups: the target sample and the most representative and accessible

community that possesses the characteristics of the target sample. The target sample (general population) encompasses the entire group of individuals or objects that the researcher aims to study, according to the criteria set by the researcher. However, the researcher may not be able to reach the entire target sample due to budget constraints, geographic location, or time limitations. Therefore, the researcher opts for a currently accessible sample that is easier to reach. This sample is a smaller subset of the general population and is limited to a smaller geographic area, a specific location, or a group that is easy to access (Tahrawi & Marah, 2022, p. 5).

In this study, the population consisted of mathematics teachers in the Muscat Governorate of the Sultanate of Oman. According to statistical data, there were 1,847 teachers and 24 supervisors during the 2022/2023 academic year, as reported by the Planning Department of the Ministry of Education (Annual Statistics Book, 53rd Edition, 2022/2023). The sample was selected randomly due to the extensive geographic spread of Oman and the distribution of its population across its governorates.

3.2 Study Tools

Study tools encompass all the means used by the researcher to collect the necessary data to answer the research questions (Al-Nooh, 2020, p. 50). In this study, content analysis and questionnaires were used to gather data.

3.3 Sampling Procedures

To achieve the study's objectives, a sample of mathematics teachers who teach grades 4 and 8 in the Muscat Governorate of the Sultanate of Oman was selected during the second semester of the 2022/2023 academic year. The sample comprised 80 teachers and supervisors, including 36 female teachers and 35 male teachers in public schools. The remaining nine participants were supervisors. They were randomly selected due to Oman's extensive geography and distribution across its governorates. The study sample also included the content of the Cambridge Mathematics series textbooks (student book and activity book) for grades 4 and 8, covering both the first and second semesters in Oman.

3.3 Measures and Covariates

The study's methodology and population were presented, along with the development of the tools used in the study. This was done by utilizing educational studies and research, and relevant educational literature, such as the studies by Al-Abd (2016), Al-Jahouri and Al-Kharousi (2010), Al-Husain (2015), Al-Gharabli and Al-Abd (2015), Dahman (2014), and Mohammed (2015). Additionally, a list of criteria from the Trends in International Mathematics and Science Study (TIMSS, 2019) was prepared for this study. The validity and reliability of the tools used were verified, and the steps for conducting the study and the statistical methods used to answer the research questions were reviewed.

4. Results and Discussion

These results are largely consistent with previous studies in this field. For example, Tubaza's study (2018) aimed to evaluate the content of Palestinian mathematics textbooks for grades 4 and 8 in light of the 2015 TIMSS standards. The results for grade 4 showed that the area of numbers ranked first in the content dimension at 80.24%, which is 30.24% higher than expected, while the area of geometric shapes and measurements achieved 14.81%, which is lower than the required 20%. Similarly, Al-Kalib's study (2018) aimed to analyze the content of mathematics textbooks for grades 5 to 8 in Saudi Arabia to determine the extent of compliance with the 2015 TIMSS standards in the content areas (numbers, algebra, geometry, data, and probability). The results revealed a high focus on the 2015 TIMSS standards in the numbers area at 54.94%, which is 24.94% higher than expected.

The study results also aligned with Ghanam's study (2020), which aimed to investigate the extent to which the 2019 TIMSS standards are included in the content of the grade 4 mathematics curriculum in Egypt and the UAE. The research found that the Egyptian mathematics curriculum achieved the content areas of numbers, geometry, and measurement according to the 2019 TIMSS standards, except for the data area, which was not adequately achieved. Meanwhile, the UAE mathematics curriculum achieved the numbers area of the 2019 TIMSS standards but did not meet the standards for measurement and geometry, and data.

However, these findings differ from Al-Habib's study (2019), which aimed to assess the inclusion of TIMSS requirements in the grade 4 mathematics textbook in Saudi Arabia. The study concluded that the mathematics textbooks from grades 1 to 4 in primary education did not meet the specified proportions for the TIMSS standards in the mathematics content area, recommending a review of the curricula in the study sample.

4.1 Summary of Study Results

After presenting the results the study concludes with the following findings based on the research questions:

- Analysis of responses from teachers and supervisors showed that for grade 4, the "knowledge" dimension was rated highest, followed by "application," and then "reasoning."
- The "knowledge" dimension had high agreement on items like recalling definitions and geometric properties, and distinguishing shapes, numbers, formulas, and quantities. Lower agreement was found for performing algorithms on integers and using measurement tools.
- In the "application" dimension, high agreement was noted for applying strategies to solve familiar mathematical problems. Lower agreement was found for creating equivalent representations and modeling problems.
- For the "reasoning" dimension, high agreement was observed on identifying and describing relationships between mathematical elements. Lower agreement was found for generalizing results and providing mathematical justifications.
- For grade 8, the "knowledge" dimension was again rated highest, followed by "application," and "reasoning."
- High agreement in the "knowledge" dimension for grade 8 included recalling properties of numbers and geometric properties. Lower agreement was found for performing combined operations and using appropriate measurement tools.
- In the "application" dimension, high agreement was noted for solving familiar problems with known strategies. Lower agreement was found for presenting data in various formats and creating mathematical models.
- High agreement in the "reasoning" dimension involved using relationships between mathematical elements and integrating knowledge to solve problems. Lower agreement was found for evaluating problem-solving strategies and suggesting alternatives.
- Statistically significant differences were found for the experience variable, with less than 15 years of experience showing higher agreement.
- The hypothesis stating no significant differences due to experience in the availability of TIMSS 2019 standards for grade 4 cognitive operations was rejected.
- No significant differences were found for the job function variable in cognitive operations dimensions for both grades 4 and 8.
- The hypothesis stating no significant differences due to gender in the availability of TIMSS 2019 standards for grade 8 cognitive operations was accepted.
- The hypothesis stating no significant differences due to experience in the availability of TIMSS 2019 standards for grade 8 cognitive operations was accepted.

4.2 Ancillary Analyses

As shown in Table 1, the means and standard deviations of responses from teachers and supervisors for each criterion in the first domain of cognitive operations (knowledge, application, and reasoning) - the knowledge domain - are displayed, along with ranks and agreement levels according to the five-point Likert scale.

Table 1: Means, Standard Deviations, and Ranks for Knowledge Domain Criteria

No. Items		Rank	Mean	Standard Deviation	Agreement Level
2	Recalls number properties and geometric properties	1	4.15	0.94	High
3	Distinguishes numbers, formulas, quantities, and shapes	2	4.13	0.86	High
6	Imports information from graphs, tables, texts, and other sources	3	4.13	0.84	High
1	Recalls definitions, terms, and units of measurement	4	4.12	0.85	High
4	Classifies numbers, formulas, quantities, and common shape properties	5	4.09	0.90	High

No. Items	Rank	Mean	Standard Deviation	Agreement Level
Performs the four arithmetic operations or a combination of these on integers, decimal fractions, common fractions, and algebraic operations	5	4.06	0.84	High
Uses measurement tools and appropriate measurement units	7	3.97	0.96	High

Table 1 indicates that teachers and supervisors in the study sample strongly agree that the grade 8 Cambridge Mathematics curriculum in Oman meets all the criteria for the knowledge domain within cognitive operations. The second criterion (recalls number properties and geometric properties) ranked first with a mean of 4.15, while the seventh criterion (uses measurement tools and appropriate measurement units) ranked last. The means for the other knowledge domain criteria ranged from 3.97 to 4.13.

The criteria regarding receiving the highest agreement from teachers and supervisors are as follows:

- Recalls number properties and geometric properties
- Distinguishes numbers, formulas, quantities, and shapes, for example, equivalencies of fractions, decimals, and ratios.

The criteria regarding receiving the lowest agreement are:

- Performs the four arithmetic operations or a combination of these on integers, decimal fractions, common fractions, and algebraic operations
- Uses measurement tools and appropriate measurement units

Figure 1 shows the normal distribution curve for the knowledge domain criteria.

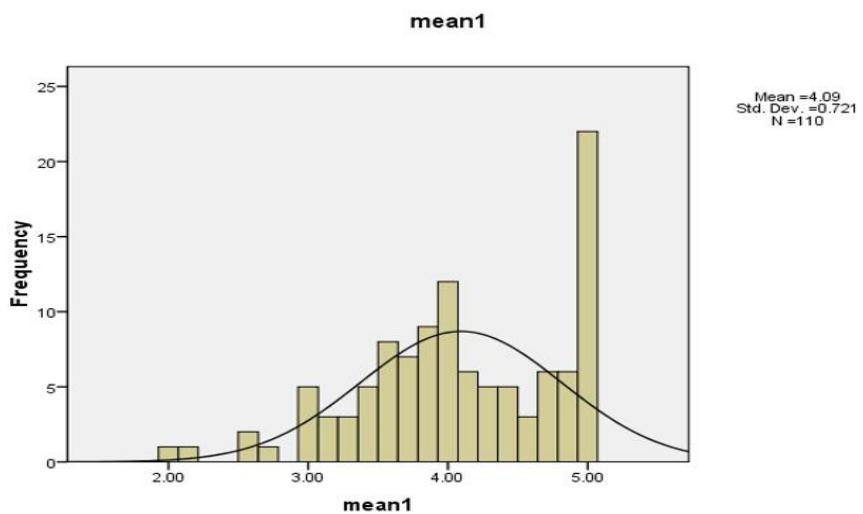


Figure 1: Normal Distribution Curve for the Knowledge Domain

4.3 Discussion

Discussion of the Results of Research one of the Question

To what extent does the content of the Cambridge Mathematics series for grade 8 in Oman incorporate the TIMSS 2019 standards in the cognitive domains (knowledge, application, and reasoning) from the perspective of mathematics teachers and supervisors in Oman?

The primary purpose of curriculum evaluation is to assess the curriculum's modernity and effectiveness. It also aims to examine whether the program objectives are being met and whether students are acquiring essential knowledge, skills, and social values (Hunkins, 2018; Marsh & Willis, 2007; Ornstein, 2018). One of the leading models in educational curriculum evaluation is the CIPP (Context, Input, Process, and Product) Evaluation Model, widely used for evaluating educational curricula (Al-Tamimi, 2008). This model encompasses four types of evaluation: context evaluation, input evaluation, process evaluation, and product

evaluation (Al-Zamli et al., 2009). The main objective of this model is to determine whether the objectives have been achieved and to what extent, and to decide whether to continue or modify the curricula.

The statistical analysis of responses from the study sample of teachers and supervisors regarding the inclusion of cognitive operations content in the grade 8 textbook revealed that, from their perspective, the "knowledge" dimension was rated highest, followed by the "application" dimension, and the "reasoning" dimension, all with significant approval.

The highest agreement among respondents on the "knowledge" dimension was related to items involving the recall of number properties and geometric properties, as well as distinguishing numbers, formulas, quantities, and shapes. Examples include equivalencies of fractions, decimals, and ratios. Conversely, the lowest agreement levels were found for items related to performing the four basic arithmetic operations or combinations thereof on integers, decimal fractions, common fractions, and algebraic operations, as well as using measurement tools and appropriate units.

In the "application" dimension, the highest agreement was on items related to implementing strategies and processes to solve familiar mathematical problems and selecting effective and appropriate operations and strategies for problem-solving. Lower agreement was noted for items involving presenting data in tables, graphs, geometric figures, inequalities, equations, numbers, or diagrams for modeling problem solutions and equivalent representations of mathematical forms.

For the "reasoning" dimension, the highest agreement was observed for items related to identifying, describing, or using relationships between numbers, formulas, quantities, and shapes, and linking various elements of knowledge and related data to solve problems. Lower agreement was found for items regarding evaluating problem-solving strategies and suggesting alternative solutions.

This suggests that the grade 8 mathematics curriculum focuses more on lower-order cognitive processes rather than higher-order processes, which are essential for stimulating critical thinking and problem-solving skills. This finding is inconsistent with what Khalil and Al-Nazeer (2019) highlighted about the necessity of employing mathematics teaching in curricula to provide experiences and activities that positively prepare individuals for life. They suggested that teaching practices should encourage self-learning, creativity, innovation, decision-making, responsibility, research, inquiry, and the use of technology, while also motivating students to participate in solving societal problems and issues.

5. Conclusion

Based on the research findings, several recommendations can enhance the inclusion of the TIMSS 2019 standards in the Cambridge Mathematics series for grades 4 and 8 in Oman, particularly in the cognitive domains (knowledge, application, and reasoning):

- **Empowering Curriculum Developers and Educators:** It is essential to grant curriculum developers, supervisors, and teachers the confidence to participate in the preparation and development of forward-looking and engaging mathematics curricula.
- **Encouraging Innovation:** Fostering both individual and collective innovation among supervisors, teachers, and curriculum developers in the field of mathematics is crucial.
- **Promoting Digital Transformation:** Increasing the shift from physical to digital spaces by leveraging networking and communication technologies will enhance collaboration and information exchange with other countries and provide necessary support chains for future market innovations.

Suggestions for Further Research

1. **Longitudinal Studies:** Future research could involve longitudinal studies to capture long-term trends and variations in the curriculum's effectiveness.
2. **Broader Geographic Scope:** Expanding the study to include other regions of Oman would provide a more comprehensive view of the curriculum's alignment with TIMSS standards.
3. **In-Depth Qualitative Studies:** Conducting in-depth qualitative studies on classroom practices and student engagement could provide more insights into the practical aspects of curriculum implementation.

Limitations

1. **Sample Size and Scope:** The study's sample, while substantial, is limited to the Muscat Governorate. This geographic limitation may affect the generalizability of the findings to other regions or different educational contexts.
2. **Resource Constraints:** Data collection was restricted to a single academic year, which may not capture long-term trends and variations.
3. **Self-Reported Data:** The use of questionnaires may introduce biases, as responses are self-reported and may reflect perceived expectations rather than actual practices.

Overall, the study's findings provide a solid foundation for improving the mathematics curriculum in Oman, with potential implications for other educational contexts. By addressing the limitations and building on the strengths, further research and practical applications can contribute to achieving higher educational standards and better learning outcomes for students.

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