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STATISTICAL STUDY OF CONTENT ANALYSIS OF THE TEXTBOOKS IN ACCORDANCE TO INTERNATIONAL MATHEMATICS AND SCIENCE STUDY (TIMSS) 2019 REQUIREMENTS

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Abstract
The current study aimed to identify the requirements of the Trends in International Mathematics and Science Study (TIMSS 2019) and assess the extent to which the content of the science textbooks aligns with the TIMSS 2019 requirements. Content analysis was used as the methodological approach to answer the research questions. The study sample consisted of the eighth-grade science textbook for the academic year 2021-2022 used in the schools of the Sultanate of Oman. The study identified and organized the requirements in a tool based on the TIMSS 2019 framework for the eighth-grade level. After ensuring the validity and reliability of the tool, data were collected and statistically analysed using frequencies and percentages. The results revealed a general deficiency in all domains in terms of content alignment, with a coverage of only 36.8% of the TIMSS 2019 requirements, including key topics, subtopics, and performance indicators. The results also show that all cognitive process skills have been covered, with percentages that are relatively close to the percentages specified by TIMSS 2019.

Keywords: Content dimension, Cognitive process dimension, science, eighth-grade, Sultanate of Oman, TIMSS 2019.

Introduction

As knowledge accumulates and scientific discoveries accelerate, there emerges an enduring challenge in education, namely the continuous updating of textbooks and educational activities. While the fields of humanities may undergo changes at a slower pace, the natural sciences (such as physics, chemistry, biology, and geology) are constantly enriched with new discoveries. Consequently, curriculum designers in the field of science face a different and significant challenge in incorporating this vast amount of new knowledge into their curricula, updating content, objectives, teaching activities, and assessments.

Considering this rapid change in human knowledge, it is natural for educators to shift their perspective on science education and strive to simplify science. This is to ensure that our children are equipped to adapt to the ever-evolving advancements, particularly in the rapidly changing world of technology. They need to be capable of solving the problems they encounter and ensuring their safety in dealing with modern technology. These tools should be beneficial and supportive for them in their lives (Al-Bazz, 2005 & Abdelkarim & Abuiyada, 2016).

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Science curricula worldwide have undergone significant reform efforts to align with the demands of the modern era and rapid advancements. Numerous studies and conferences have been conducted to establish the standards upon which science curricula should be based to keep up with the immense and swift international developments in the field of science curriculum development (Abdul Salam, 2006 ; Abdulkarim and Jadiry, 2012; Abdulkarim et. al. 2016,).

Countries have realized that the reform and development of educational systems must be based on multiple educational studies and research. The results of these studies and research are used in a scientific manner to serve the development of educational decisions. The Trends in International Mathematics and Science Studies (TIMSS) is one of the most prominent international studies and the most participated by countries at the global level. It has played a major and important role in developing educational policies and practices. TIMSS aims to assess the level of students in the subjects of mathematics and science around the world on a regular basis every four years. It is worth mentioning that the national standards for science education developed by the National Science Teachers Association (NSTA) in the United States are the same standards used in the TIMSS project (Al-Arja, 2009 & Abdulkarim and Raburu, 2013).

The Trends in International Mathematics and Science Study (TIMSS) is administered by the International Association for the Evaluation of Educational Achievement (IEA), which is one of the largest organizations worldwide dedicated to studying educational achievement. This organization was established in 1959 in the Netherlands. In 1990, the IEA approved the direction of regularly assessing students' performance in science and mathematics every four years. The first administration of the test took place in 1995 and was known as the TIMSS test at that time (Mullis et al., 2008).

The primary objective of conducting this test is to determine the achievement levels of students in the subjects of science and mathematics at the global level for the fourth and eighth grades. Additionally, it aims to assist participating countries in developing their educational systems through indicators that facilitate the teaching and learning of science and mathematics. The TIMSS project has been developed to describe students' learning and gather data on students' attitudes, teacher practices, and school experiences. Regarding the science subject, these tests are designed based on two fundamental dimensions: content dimension and cognitive processes dimension (Mullis et al., 2008).

Global participation in this test has been increasing steadily. In the first round in 1995, 26 countries participated in the fourth-grade test and 41 countries in the eighth-grade test. In the 1999 round, 38 countries participated in the eighth-grade test and the fourth-grade test was not held. In the 2003 round, 25 countries participated in the fourth-grade test and 46 countries in the eighth-grade test. In the fourth round in 2007, 36 countries participated in the fourth-grade test and 48 countries in the eighth-grade test. In the fifth round in 2011, 50 countries participated in the fourth-grade test and 42 countries in the eighth-grade test. In 2015, 57 basic countries and seven districts and cities for comparison (benchmarking) participated, of which 49 countries participated in the mathematics test and 47 countries participated in the science test for the fourth grade. As for the eighth grade,

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39 countries participated in the science and mathematics tests, while the seven cities and districts participated in the science and mathematics tests for the fourth and eighth grades (Mullis et al., 2016).

Problem Statement

Oman participated early in the TIMSS assessment, beginning in 2007 for eighth-grade students and delaying participation for fourth graders until the following cycle in 2011. Overall, student results were below the international average (500). Fourth graders showed improvement between the 2011 and 2015 cycles, while eighth-grade results varied across cycles in both subjects (mathematics and science). For example, in the mathematics assessment, the average for fourth graders rose from 385 in 2011 to 425 in 2015. In the science assessment, the average for fourth graders rose from 377 in 2011 to 431 in 2015. As for eighth-grade students' results in the science assessment, they scored an average of 423 in 2007, then decreased slightly to 420 in 2011, then returned to rise to 455 in 2015. It is worth noting that the same pattern was repeated for mathematics, with students scoring an average of 372 in 2007, then decreasing slightly to 366 in 2011, then returning to rise to 403 in 2015 (Mullis et al., 2016).

In terms of the results of Omani students in the 2019 fourth grade cycle, they achieved a slightly higher achievement rate than the previous cycle, at 435 points, compared to 431 points in the previous cycle. For the eighth grade, the students of the Sultanate maintained a similar performance to the previous cycle with a slightly higher achievement rate of 457 points, compared to 455 points in the 2015 cycle (Ministry of Education and Learning, 2023).

The previously mentioned results of Omani students have drawn the attention of many researchers to understand the reason for the low levels of students in TIMSS tests in science subjects in the Sultanate, such as Kamil (2019) and Abd (2016). The research has concluded that the decline is linked to the content of textbooks and their failure to include the appropriate requirements of the international study, and it also emphasized the need to subject the content of the curricula to study and analysis considering the standards of this study (TIMSS). In this context, Al-Rikabi (2016) confirms the relationship between the reasons related to the curriculum and its teaching and the poor performance of students in tests.

Given the importance of the TIMSS project and the comprehensive and international comparative data it provides on the concepts and attitudes that students have learned in the subjects of science and mathematics in the fourth and eighth grades, and the measurement and interpretation of the differences between the educational systems in the participating countries and the assistance in developing the teaching and learning of mathematics and science and benefiting from the experiences of countries that have achieved successes in the field of teaching mathematics and science, these were among the most important reasons that prompted the research team to choose

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the standards of the TIMSS 2019 project to analyse the content of science textbooks in the Sultanate.

Study Questions

The study problem was defined in the following main question:

To what extent does the science textbook for the eighth grade in the Sultanate of Oman include the requirements of (TIMSS 2019)?

The following sub-questions branch out from the main question:

1) What are the requirements of the TIMSS 2019 test for the two content dimensions (biology, chemistry, physics, earth sciences) that must be met in the science textbook for the eighth grade in the Sultanate of Oman?

2) To what extent does the science book for the eighth grade in the Sultanate of Oman include the content dimension of science books (biology, chemistry, physics, and earth sciences) according to the requirements of (TIMSS 2019)?

3) To what extent does the science book for the eighth grade in the Sultanate of Oman include the cognitive process dimension of science books (Knowledge, Application, and Reasoning) according to the requirements of (TIMSS 2019)?

Objectives of the study

- Determine the requirements for the TIMSS 2019 test for the content dimensions (biology, chemistry, physics, earth sciences) that must be present in the science textbook for the eighth grade in the Sultanate of Oman.
- Content analysis of the science book for the eighth grade in the Sultanate of Oman considering the requirements of the TIMSS 2019 test.
- Evaluating the extent to which the science textbook for the eighth grade in the Sultanate of Oman includes the content dimension and cognitive process dimension of science books (biology, chemistry, physics, earth sciences) according to the requirements of (TIMSS 2019).

TIMSS 2019 project requirements for the eighth grade

The requirements of the (TIMSS 2019) project for the eighth grade for science consist of two dimensions: the science content dimension, and the cognitive processes dimension, where the content dimension includes four fields: life sciences, physical sciences, chemical sciences, and earth sciences, and then they are represented in specific weight ratios, as the following table shows it.

Table 1- *Content of the science curriculum for the eighth grade considering the standards (TIMSS 2019)*

TIMSS 2019 Requirements			
Content Dimension		Cognitive Process Dimension	
Content areas	percentage	Skill	percentage
Biology	35%	Knowledge	35%
Physics	25%	Application	35%

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Chemistry	20%	Reasoning	30%
Geology	20%		

Method and procedures

Study Approach:

In this study, the research team used the analytical descriptive approach, which is defined by Adass (1999) as a method that quantitatively describes the studied phenomenon, such as books and documents, to judge its validity depending on a few variables, such as finding the number of occurrences of certain things. The research team collected information from the study sample, the science book for the eighth grade in the Sultanate of Oman for the academic year 2021-2022, using the content analysis method, then analysing and interpreting this information and presenting its results. Issuing a judgment regarding the compatibility of these courses with the general standards of the curricula, which should be adhered to by any academic curriculum in general.

Study tool

To achieve the objectives of the current study and to answer its questions, the research team built a content analysis tool for the science textbook for the eighth grade for the content dimension (biology, chemistry, physics, earth sciences) and for the Cognitive Processes dimension and Cognitive Process Dimension in accordance with the requirements of (TIMSS 2019).

Building a Requirements List (TIMSS 2019)

The TIMSS 2019 list was built by reviewing the topics and standards approved by the International Association for the Evaluation of Educational Achievement (IEA). Available on the official website:

https://www.iea.nl/publications/assessment-framework/timss-2019-assessment-frameworks

Then, the list was translated into Arabic, where the translation was carried out by a faculty member at Dhofar University specializing in translation with the rank of assistant professor. This process was paid and took the professor a period amounting to three months.

Related studies were also reviewed, such as Abd (2016), Al-Hussan (2015), Dahman (2014), Al-Fahidi (2012), Mousa (2012), as well as Al-Jahouri and Al-Kharusi (2010).

The researchers reviewed the TIMSS 2019 test framework to identify the specific content and cognitive processes that are expected to be covered in the eighth-grade science textbook in Oman. This information was used to prepare an initial list of content and cognitive processes for grade 8.

The initial list was then reviewed by a group of experts in the fields of curriculum, science teaching methods, educational measurement and evaluation, Arabic language, and translation. The experts provided their feedback and suggestions on the list to ensure the accuracy of the translation and clarity.

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To determine the extent to which the eighth-grade science textbook in Oman meets the requirements of TIMSS 2019, the research team prepared content analysis cards following the following steps:

1. **Defining the purpose of the analysis**

The analysis aims to identify the extent to which the requirements of TIMSS 2019, according to the lists that have been prepared, are available in the content of the eighth-grade science textbook for the Omani curriculum.

2. **Determining the sample for analysis**

The sample for analysis is all the academic topics included in the eighth-grade science textbook for the Omani curriculum and applied for the academic year 2021-2022.

3. **Determining the analysis categories**

The analysis categories in this study are the TIMSS 2019 requirements list, which consists of the content dimension and the cognitive processes dimension.

4. **Determining the unit of analysis**

There are five types of analysis units: word, topic, idea, person, and paragraph (Taeimah, 2004). The full paragraph containing an idea will be chosen as the unit of analysis, which is based on the monitoring of analysis categories due to its suitability for the nature of the current study. The paragraph is a set of interrelated sentences that may extend to a page, and in this study, the paragraph will be adopted as the unit of registration.

Validity of the tool:

Validity means "the extent to which the tool achieves the purpose for which it was prepared, so it measures only what it was designed to measure" (Al-Agha, 1997). The validity of the tool was estimated based on the honesty of the arbitrators. The tool was presented in its final form to a group of specialists in measurement and evaluation, and in curricula and teaching methods, from faculty members in the Department of Education and some science supervisors and teachers, to ensure the apparent validity of the tool and review its items.

Reliability of the tool:

Reliability means obtaining the same results when the measurement is repeated using the same tool under the same conditions. The reliability coefficient has been calculated through stability over time and then consistency across individuals, where another specialist performs the analysis.

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After that, the stability coefficient is calculated through a number Times of agreement between analysts divided by the total number of categories analysed (Holsti equation to calculate the reliability coefficient of the instrument).

First: Consistency over time. The main researcher did this by analysing the electricity and magnetism unit from the eighth-grade textbook. Then the main researcher repeated the analysis again after a period of two weeks, and the following table summarizes the results of the analysis:

Table No. (3-1) - ***The content analysis of the electricity and magnetism unit (analysis over time)***

1st Analysis	2nd Analysis	Agreement	difference
135	141	135	6

The reliability coefficient was calculated using the following Cooper equation: (Attiya, 2009)

$$r = \frac{Agreaments}{Agraeaments + Differences} x100\%$$

$$r = \frac{141}{141+6} x100\% = 95.74\%$$

Second: Inter-rater reliability is a measure of consistency used to evaluate the extent to which different judges agree in their assessment decisions. Three analysts working as supervisors in the Ministry of Education analysed the electricity and magnetism unit from the eighth-grade textbook, and the result of the reliability coefficient between each analyst was as follows, Table No. (3-2):

Table No. (3-2) - ***Inter-ratter reliability***

	1st Analyst	2nd Analyst	3rd Analyst
1ST Analyst	1	96.50	95.65
2nd Analyst	96.50	1	92.30
3rd Analyst	95.65	92.30	1

Which shows that the tool has a high degree of reliability, so that the research team is reassured of the suitability of the tool for the analysis.

Stability of the Instrument for the Cognitive Processes Dimension

First: Stability over Time

The main researcher conducted the stability over time analysis by analysing the electricity and magnetism unit from the eighth-grade science textbook for the cognitive processes dimension (knowledge, application, inference). The main researcher then repeated the analysis again after a period of two weeks. The stability coefficient was calculated using the following Cooper equation:

Table No. (3-3) - ***The stability coefficient***

	Knowledge	Application	Reasoning	Total
First Analysis	25	29	22	76
Second Analysis	25	31	24	80

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Number of Agreements	25	29	22	76
Number of Disagreements	0	2	2	4
Stability Coefficient	100%	93.55%	91.67%	95%

Second: Stability of Consistency across Individuals

Three analysts working as supervisors in the Ministry of Education analysed the electricity and magnetism unit for the application field only from the eighth-grade science textbook. The result of the stability coefficient between each analyst was as follows:

Table No. (3-4)

The stability coefficient

	Analyst 1	Analyst 2	Analyst 3
Analyst 1	1	90.63	96.55
Analyst 2	90.63	1	87.5
Analyst 3	96.55	87.5	1

The analysis showed that the instrument has a high degree of stability, which reassures the research team that the tool is suitable for analysis.

Regulations and Procedures for the Analysis Process:

1. The analysis was conducted within the scientific content of the eighth-grade science textbook in the Omani curriculum, excluding the index and introduction of the book.
2. The analysis includes the topics of the eighth-grade science textbook, part one, part two, and the student book.
3. The analysis includes the evaluation questions included at the end of each unit, chapter, or section.
4. The analysis includes the illustrations, figures, and activities in the content.
5. The analysis was conducted by experts (teachers and supervisors with extensive experience working in the Omani Ministry of Education) in teaching the eighth-grade science textbook. The analysis process was paid, and the process of selecting these experts went through several stages until selecting the Analysts.
6. Meeting with the selected analysts to clarify the project to them and any inquiries they raised.
7. Conducting a first workshop for four (4) hours, in which the research team and research assistants engaged in analyzing a complete unit from the eighth grade. There were extensive discussions about many questions, including images, shapes, and how to deal with them, and questions at the end of each section, etc.

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8. Conducting a second workshop in which each analyst was given a unit from the eighth-grade science textbook and asked to analyze it individually. Then, the results of the analysis were discussed, and the research team found that there were still some points on which there was disagreement.
9. Conducting a third workshop, at the end of which each analyst was given the same unit from the eighth grade and asked to analyze it individually. Then, the results of the analysis were discussed, and the research team found that there was a great deal of agreement among all the analysts on all points, and the results of the analysis were close.
10. The actual analysis procedures were as follows:

- Obtaining the latest edition of the eighth-grade science textbook that was assigned to students in the grade chosen in the academic year 2021-2022.
- Studying and reading the list of main and subsidiary standards for TIMSS criteria several times, then reading each unit of the units in full to identify the field to which it belongs and the ideas it contains.
- A second careful reading of the science books (study sample) for each unit of the book, contemplating all that came in it from chapters, topics, questions, shapes, images, and activities. The introduction of the book and the index were excluded to reveal the extent to which they include or do not include TIMSS criteria and to calculate their frequency.
- The analysis process was first carried out on the book, whereby each paragraph was studied and the standard that the paragraph contains was placed according to the approved coding system.
- The analysis was carried out on the book with a ballpoint pen using blue only.
- The review process was carried out by another researcher using a ballpoint pen and green only on the book.
- If there was a disagreement between the analyst and the reviewer on some paragraphs, a meeting would be held between them to reach the right decision after the agreement of the two parties. If they did not reach an agreement, the main researcher would intervene to resolve the decision.
- This process took a period ranging from three and a half to four months, depending on the circumstances of each analyst.
- **The counting and statistics stage and the transfer of the results of the analysis from symbols on the schoolbook to repetitions on the final analysis list. This was done by placing a (√) mark in the appropriate place inside the form. If the standard is included, a (√) mark is placed in the "included" box and the number of repetitions**

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for each standard is calculated and placed in the box provided for that in the form. If the standard is not included, a (√) mark is placed in the "not included" box.

- **The next stage is to collect the results and verify the counting and statistics, compare the numbers on the books with the numbers and repetitions on the analysis list, and then collect the results for each dimension in the form of tables and charts.**

Results and Discussions

To answer the first sub-question, which reads: "What are the requirements of the (TIMSS 2019) test that must be met in the content of science books for the eighth grade in the Sultanate of Oman based on the content dimension?" the results were as follows:

The field of Biology: It contains (6) main topics and (16) sub-topics under which a number of goals (performance indicators) fall, numbering (35).

The field of Chemistry: It contains (3) main topics and (10) sub-topics under which a number of (23) objectives (performance indicators) fall.

The field of Physics: It contains (5) main topics and (12) sub-topics under which a number of (26) goals (performance indicators) fall.

The field of Earth Sciences: It contains (4) main topics and (9) sub-topics under which a few goals (performance indicators) fall, numbering (22).

Table (4-1) shows the main topics, the number of subtopics, and the number of objectives (performance indicators) for the four areas of the eighth grade according to the requirements of the TIMSS 2019 test:

Table (4-1)

Main topics, number of subtopics, number of objectives (performance indicators) for the four fields according to the requirements of the TIMSS 2019 test.

	Domain	Main topics	Number of subtopics	Number of objectives
1	Biology	Characteristics and life processes of organisms	3	6
		Cells and their functions	2	6
		Life cycles, reproduction, and heredity	2	4
		Diversity, adaptation, and natural selection	2	4
		Ecosystems	5	11
		Human health	2	4
	Total	6	16	35
2	Chemistry	Composition of matter	3	5
		Properties of matter	4	11
		Chemical change	3	7
	Total	3	10	23

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3	Physics	Physical states and changes in matter	3	6
		Energy transformation and transfer	2	5
		Light and sound	2	4
		Electricity and magnetism	2	4
		Motion and forces	3	7
	Total	5	12	26
4	Earth Science	Earth's structure and physical features	2	4
		Earth's processes, cycles, and history	3	9
		Earth's resources, their use, and conservation	2	5
		Earth in the Solar System and the universe	2	4
	Total	4	9	22
	Summation of all	18	47	106

The requirements of the TIMSS 2019 assessment that must be met in the content of the eighth-grade science textbooks in Oman for the cognitive domain were as follows:

The cognitive domain is divided into three domains that describe the thinking processes that students are expected to use when they solve science questions that were developed for TIMSS 2019.

Domain 1: Knowledge: This domain deals with the student's ability to remember, identify, describe, and provide examples of facts, concepts, and procedures necessary to build a solid foundation in science.

Domain 2: Application: This domain focuses on using this knowledge to create comparisons, contrasts, and classifications of groups of objects or materials; relate knowledge to a science concept within a specific context; create explanations and interpretations of scientific scenarios and solve practical problems.

Domain 3: Reasoning: This domain involves using evidence and understanding scientific concepts through analysis, synthesis, and generalization, often in unfamiliar situations and complex contexts.

These three domains are used for both fourth and eighth grade. However, the target percentage for each domain varies in fourth and eighth grade based on the increasing cognitive ability, instruction, experience, and expansion and depth of student understanding at the higher grade level.

The percentage of vocabulary related to knowledge is higher in fourth grade compared to eighth grade, while the percentage of vocabulary that requires students to engage in reasoning is higher

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in eighth grade. While there is some overlap between the three domains (from knowledge to application to reasoning), each domain contains vocabulary that represents a full range of difficulty.

Table 4-2 - ***Each domain and the vocabulary associated with it, while Table 4-3 shows the target percentages for each of the three domains in eighth grade.***

	Domain	Skill
1	Knowing	Recall/Recognize
		Describe
		Provide Examples
	Total	3
2	Applying	Compare/Contrast/Classify
		Relate
		Use Models
		Interpret Information
		Explain
	Total	5
3	Reasoning	Analyze
		Synthesize
		Formulate Questions/ Hypothesize/ Predict
		Design Investigations
		Evaluate
		Draw Conclusions
		Generalize
		Justify
	Total	8
	All	16

Question 2: To what extent does the eighth-grade science textbook in Oman include the content dimension of science textbooks (biology, chemistry, physics, and earth science) in accordance with the requirements of TIMSS 2019? To answer this question, the frequencies and percentages for each content domain of the eighth-grade science content domain were calculated and the results were summarized in Table 4-3.

Table 4-3 - ***Percentage of the number of sub-goals included in the book to the total content included.***

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Content domain	Number of sub-goals according to TIMSS 2019 requirements	Number of sub-goals included in the textbook	Percentage of the number of sub-goals included in the book to the total content included
Biology	35	15	38.5 %
Chemistry	23	14	35.9 %
Physics	26	9	23.0 %
Earth science	22	1	2.6 %
Total	106	39	36.8%

The table above shows that the number of sub-goals specified by TIMSS 2019 is 106, while only 39 of them were included, which represents only 36.8%. Therefore, there are 67 sub-goals that were not included, representing 63.2%. This result is consistent with both the study by Al-Kamshakiya and Al-Shahat (2021) and the study by Abu Kamel (2019).
For the field of biology, 15 of the 35 required sub-goals were included, and this is due to the fact that some sub-goals of the TIMSS 2019 don't exist at all such as: Differences among major taxonomic groups of organisms, Physiological processes in animals, Variation as the basis for natural selection, Interdependence of populations of organisms in an ecosystem, Factors affecting population size in an ecosystem, and Human impact on the environment.

In the field of chemistry, 14 of the 23 required sub-goals were included in the eighth-grade science textbook in Oman. This is because the following sub-goals were not included at all or in part:

- Physical and chemical properties of matter
- Physical and chemical properties as a basis for classifying matter
- Chemical bonds
- Properties of acids and bases
- Matter and energy in chemical reactions

In the field of physics, the textbook included 9 of the 26 required sub-goals. This is since the following sub-goals were not included at all or in part:

- Motion of particles in solids, liquids, and gases
- Changes in the states of matter
- Physical changes
- Forms and conservation of energy

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- Heat transfer and thermal conductivity of materials
- Known forces and their properties.

In the field of earth science, only one of the 22 required sub-goals was included in the eighth-grade science textbook in Oman. This was the sub-goal that addresses the requirement of the sun, stars, Earth, moon, and planets. The remaining requirements were completely absent, and they are as follows:

- Earth's structure and physical characteristics
- Components of Earth's atmosphere and atmospheric conditions
- The Earth's geological processes
- The water cycle on Earth
- Weather and climate
- Managing Earth's natural resources
- Land and water use
- Observable phenomena on Earth resulting from movements of Earth and the Moon

To determine the frequencies, percentages, and rankings of the four included fields, the results were summarized in Table 4-4

Table 4-4 - ***Frequencies, percentages, and rankings of the four included fields***

	Field	Frequency	Percentage %	Ranking	Required percentage according to TIMSS 2019
1	Biology	426	32.3	2	35 %
2	Chemistry	326	24.7	3	20 %
3	Physics	565	42.8	1	25 %
4	Earth science	3	0.2	4	20 %
		1320	100%		100 %

From the table above, we note that there is a difference in all fields between the percentages included in the book and those specified in the TIMSS 2019 test. In the field of biology, the difference was less than three (3) percentage points, and in the field of chemistry it increased to less than five (5) percentage points. In the field of physics, the difference became very sharp, with a difference of more than (17) percentage points, and there was a near-total absence of the field of earth science. The ranking of the fields according to the included percentages was as follows: physics came in first place, followed by biology, chemistry, and finally earth science. The results of this study agreed completely in terms of the ranking of the fields with the results of the studie of Al-Jahwari and Al-Khoroshi (2010). It agreed partially with the results of other studies in which the field of physics was in second place, the field of biology in first place, with chemistry

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remaining in third place, and the field of earth science in last place, such as the study of Abu Kamil (2019), the study of Dainour (2015). The following is a detailed explanation of the four fields:

First: The field of biology

After the analysis process and calculation of frequencies, percentages, and rankings, the results were as shown in Table (4-5).

Table (4-5) - ***Analysis process and calculation of frequencies, percentages, and ranking for the field of biology***

	Topics	Number of main objectives	Number of sub-objectives	Frequency	Percentage	Ranking
1	Characteristics and life processes of organisms	3	6	51	11.97 %	4
2	Cells and their functions	2	6	184	43.19 %	1
3	Life cycles, reproduction, and heredity	2	4	94	22.07 %	2
4	Diversity, adaptation, and natural selection	2	4	0	0	6
5	Ecosystems	5	11	11	2.58 %	5
6	Human health	2	4	86	20.19 %	3
	Total	16	35	426	100 %	

The table above shows that the topic of "Cells and their functions" came in first place in the biology topics with a percentage of 43.19%, and the topic of "Biodiversity, similarity and difference, adaptation and natural selection" came in last place without any repetition.

Second: The field of chemistry

After the analysis process and calculation of frequencies, percentages, and rankings, the results were as shown in Table (4-6).

Table (4-6) - ***Analysis process and calculation of frequencies, percentages, and ranking for the field of chemistry***

	Topics	Number of main objectives	Number of sub-objectives	Frequency	Percentage	Ranking

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1	Composition of matter	3	5	158	48.47 %	1
2	Properties of matter	4	11	17	5.21 %	3
3	Chemical change	3	7	151	46.32 %	2
	Total	10	23	326	100 %	

The table also shows that the textbook includes the highest percentage of required sub-goals for the topic of **composition of matter** (48.47%), followed by the topic of **chemical changes** (46.32%), and **properties of matter** (5.21%).

Third: The field of physics

After the analysis process and calculation of frequencies, percentages, and rankings, the results were as shown in Table (4-7).

Table (4-7) - ***Analysis process and calculation of frequencies, percentages, and ranking for the field of physics***

	Topics	Number of main objectives	Number of sub-objectives	Frequency	Percentage	Ranking
1	Physical states and changes in matter	3	6	0	0	4
2	Energy transformation and transfer	2	5	0	0	4
3	Light and sound	2	4	260	46.02 %	1
4	Electricity and magnetism	2	4	184	32.57 %	2
5	Motion and forces	3	7	121	21.41 %	3
	Total	12	26	565	100 %	

The field of physics is the field with the highest frequency. However, there are two topics that are not included in the book, namely the physical states and changes in matter and energy transformations and transfers. The topic of sound and light came first, then electricity and magnetism, and thirdly, motion and forces.

Fourth: The field of earth science

After the analysis process and calculation of frequencies, percentages, and rankings, the results were as shown in Table (4-8).

Table (4-8) - ***Analysis process and calculation of frequencies, percentages, and ranking for the field of earth science***

	Topics	Number of main objectives	Number of sub-objectives	Frequency	Percentage	Ranking
1	Earth's structure and physical features	2	4	0	0	2
2	Earth's processes, cycles, and history	3	9	0	0	2
3	Earth's resources, their use, and conservation	2	5	0	0	2
4	Earth in the Solar System and the universe	2	4	3	100 %	1
	Total	9	22	3	100 %	

Table (4-8) clearly shows that the field of earth science is almost not included, as there are only 3 repetitions in the topic of the Earth in the solar system and the universe.

Question 3: To what extent does the eighth-grade science textbook in Oman include the cognitive process dimension (knowledge, application, inference) according to the requirements of TIMSS 2019?

To answer this question, the frequencies, and percentages of each field of the cognitive process dimension for the eighth grade were calculated. Table (4-9) shows the frequencies, percentages, and ranking of the three fields of the cognitive process dimension of the book and according to the requirements of TIMSS 2019 for the eighth grade.

Table (4-9) - ***Frequencies, percentages, and ranking of the three fields of the cognitive process dimension of the book and according to the requirements of TIMSS 2019 for the eighth grade***

Field	Total repetitions	Percentage of the book (%)	Rank	Percentage according to TIMSS 2019 (%)
Knowledge	484	37.52	2	35 %
Application	498	38.60	1	35 %
Reasoning	308	23.88	3	30 %
Total	1290	100 %		

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Table (4-9) shows that all cognitive domains have been covered, with percentages that are relatively close to the percentages specified by TIMSS 2019. Knowledge came in with an inclusion percentage of 37.52%, with a difference of only two and a half percentage points. The application process came in with a percentage of 38.60%, with a difference of about three and a half points. The inference process came in with a percentage of 23.88%, lagging behind by about six points from the percentage specified by the TIMSS 2019 test. The ranking was as follows: first application, second knowledge, and third inference.

Figure (4-1) shows the results of the percentages of topics for the cognitive domains included in the eighth-grade science textbook and their comparison with the percentage specified according to the requirements of TIMSS 2019.

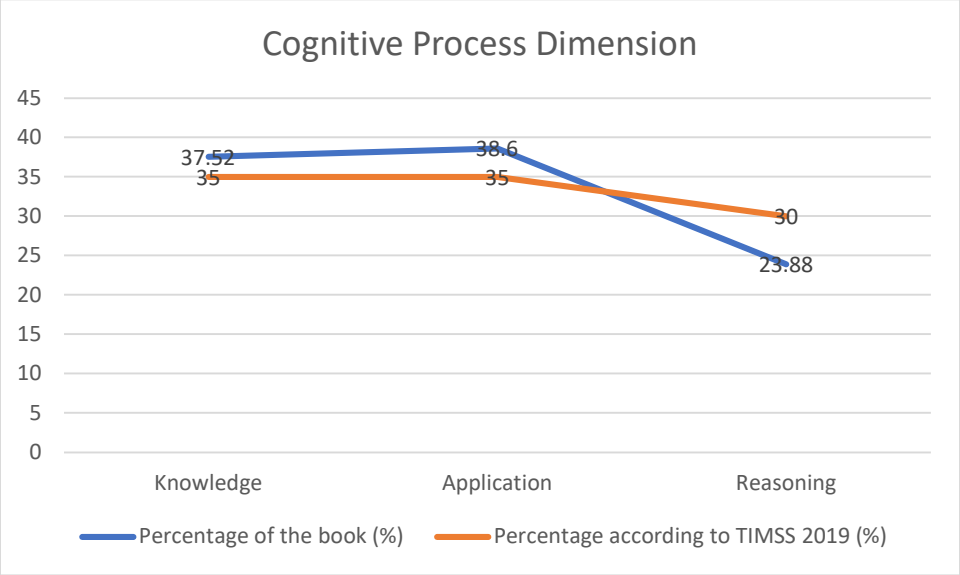

Figure (4-1): Percentages of topics for cognitive domains included in the eighth-grade science textbook and their comparison with the percentage specified according to the requirements of TIMSS 2019

And the following is a detailed breakdown of the three domains of the cognitive process dimension.

First- the knowledge domain: After conducting the analysis and calculating the frequencies, percentages, and ranking, the results came as shown in Table (4-10).

Table (4-10) - ***Analysis process and calculation of frequencies, percentages, and ranking for the knowledge domain***

	Skills	Frequency	Percentage included (%)	Rank
1	Recall/Recognize	315	65.08 %	1
2	Describe	145	29.96 %	2

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3	Provide Examples	24	4.96 %	3
	Total	484	100 %	

The table shows that the recall skill was the most repeated, with a percentage of nearly two-thirds, followed by description with a percentage of about 30%, and finally providing examples with a percentage of less than 5%.

Second- the application domain: After conducting the analysis and calculating the frequencies, percentages, and ranking, the results came as shown in Table (4-12).

Table (4-11) - ***Analysis process and calculation of frequencies, percentages, and ranking for the application domain***

	Skills	Frequency	Percentage included (%)	Rank
1	Compare/Contrast/Classify	105	21.08 %	2
2	Relate	83	16.67 %	4
3	Use Models	153	30.72 %	1
4	Interpret Information	92	18.47 %	3
5	Explain	65	13.05 %	5
	Total	498	100 %	

From the previous table, we note that the skill of using models ranked first with a percentage of about 30%, and the skill of explaining came in last place with a percentage of about 13%.
Third- the reasoning domain: After conducting the analysis and calculating the frequencies, percentages, and ranking, the results came as shown in Table (4-12).

Table (4-12) - ***Analysis process and calculation of frequencies, percentages, and ranking for the inference domain***

	Skills	Frequency	Percentage included (%)	Rank
1	Analyze	23	7.47 %	5
2	Synthesize	13	4.22 %	6
3	Formulate Questions/ Hypothesize/Predict	83	26.95 %	2
4	Design Investigations	119	38.64 %	1
5	Evaluate	35	11.36 %	3
6	Draw Conclusions	28	9.09 %	4
7	Generalize	4	1.30 %	7
8	Justify	3	0.97 %	8

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Total	308	100 %

From the previous table, the skill of designing investigations topped the scene with more than 38%, while the skill of justification and issuing generalizations came in the last places.

The previous tables, which were divided according to cognitive processes, show that the eighth-grade science textbook includes all the cognitive skills for all areas. This is a strong positive point for the book. This can be explained by the fact that the eighth-grade science textbook is the Cambridge textbook, which has been translated, adapted, and aligned with the Omani environment and was recently adopted by the ministry. The Cambridge textbook is entirely based on inquiry as a main teaching approach and contains many activities, experiments, and events that students are asked to perform individually or collectively. Therefore, we find that all cognitive skills are included.

By referring to Table (4-9), we find that the included percentages do not deviate much from the required percentages according to the TIMSS 2019 test. The largest difference was in the reasoning domain, which was about (6) percentage points, and the smallest difference was about two and a half points in the knowledge domain. This is considered a success for the Cambridge textbook.

From the tables, it is also clear that even though all the skills are included, some of them have been included at a very low percentage, sometimes not exceeding 1% of the domain, such as the skill of justification in the inference domain. Others have been heavily emphasized, such as the skill of recall in the knowledge domain, where it has been included at a rate of over 65%.

Recommendations:

- The eighth-grade science textbooks in Oman should be reviewed to ensure that they cover all of the content required by the TIMSS 2019 test. This includes biology, chemistry, physics, and earth sciences. In particular, the earth sciences section is currently absent from the textbooks and needs to be added.
- A comprehensive review of the eighth-grade science textbooks in Oman is recommended to assess the balance and fairness of cognitive skill representation across the three domains of knowledge, application, and inference. This review should identify any areas where specific cognitive skills are overrepresented or underrepresented to ensure that all students have the opportunity to develop a well-rounded and balanced set of cognitive skills. Currently, some cognitive skills, such as recall and description, are included at a rate of over two-thirds in the knowledge domain, while others, such as justification and generalization, are included at less than 1% in the inference domain. This imbalance could hinder students' ability to develop higher-order thinking skills and effectively apply their knowledge to real-world problem-solving scenarios.

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