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Article Analyzing the School Mathematics Textbooks in Sultanate of Oman

مقال تحليل كتب الرياضيات المدرسية في سلطنة عمان

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Abstract:

Many students entering the statistics major at university do not have sufficient prior knowledge of the statistics content and concepts that should be taught in school. Therefore, we conducted this comprehensive analytical study of the content of mathematics textbooks prescribed in the Sultanate of Oman from grades one to twelve. Evaluating mathematics textbooks used in schools is essential to ensure they support effective teaching and meaningful learning. The aim was to evaluate the distribution of basic mathematical topics; statistics, algebra, and geometry. It also explores concepts, activities and diagrams related to statistics in particular. The research covers several important statistical topics: The number of pages and percentages of algebra, geometry, and statistics in textbooks, the frequency of statistical concepts and lessons, the classification of statistical problems, statistics-related exercises and activities, and the distribution of charts across classes. Complaints and recommendations from teachers regarding the methodology of presenting statistics and its distribution across grade levels were also monitored. A set of recommendations for developing the curricula was presented based on the findings. Statistical tests were used, such as the Chi-square test to test the distribution of frequencies of (statistics, algebra, geometry). Normality test of the quantitative data were used along with Mann-Whitney, and Kruskal-Wallis tests to analyze the questionnaire and compare the groups of mathematics teachers and to analyze the effect of demographic variables such as gender and experience of teaching on their responses.

Keywords: Mathematics textbooks, Sultanate of Oman, curriculum analysis, statistics education, algebra, geometry, content distribution, teacher opinions, educational levels, statistical concepts, curriculum development.

الملخص:

العديد من الطلاب الذين يلتحقون بتخصص الإحصاء في الجامعة ليس لديهم معرفة مسبقة كافية بمحتوى ومفاهيم الإحصاء التي ينبغي تدريسها في المدرسة. لذلك، أجرينا هذه الدراسة التحليلية الشاملة لمحتوى كتب الرياضيات المقررة في سلطنة عمان من الصف الأول إلى الصف الثاني عشر. يعد تقييم كتب الرياضيات المستخدمة في المدارس أمرًا ضروريًا لضمان دعمها للتدريس الفعال والتعلم الهادف. كان الهدف هو تقييم توزيع الموضوعات الرياضية الأساسية: الإحصاء والجبر والهندسة. كما تستكشف المفاهيم والأنشطة والرسوم البيانية المتعلقة بالإحصاء على وجه الخصوص. يغطي البحث العديد من الموضوعات الإحصائية الهامة: عدد الصفحات والنسب المئوية للجبر والهندسة والإحصاء في الكتب المدرسية، وتكرار المفاهيم والدروس الإحصائية، وتصنيف المشكلات الإحصائية، والتدريبات والأنشطة المتعلقة بالإحصاء، وتوزيع الرسوم البيانية عبر الفصول الدراسية. كما تمت مراقبة شكاوى وتوصيات المعلمين فيما يتعلق بمنهجية عرض الإحصاء وتوزيعه عبر المستويات الصفية. تم تقديم مجموعة من التوصيات لتطوير المناهج الدراسية بناءً على النتائج. تم استخدام الاختبارات الإحصائية، مثل اختبار مربع كاي لاختبار توزيع تكرارات (الإحصاء، والجبر، والهندسة). تم استخدام اختبارات الاعتدالية للبيانات الكمية جنبًا إلى جنب مع اختبارات مان ويتني وكروسكال واليس لتحليل الاستبيان ومقارنة مجموعات معلمي الرياضيات ولتحليل تأثير المتغيرات الديموغرافية مثل الجنس والخبرة في التدريس على استجاباتهم.

الكلمات المفتاحية: كتب الرياضيات المدرسية، سلطنة عمان، تحليل المناهج، تعليم الإحصاء، الجبر، الهندسة، توزيع المحتوى، آراء المعلمين، المستويات التعليمية، المفاهيم الإحصائية، تطوير المناهج.

1. General background

Mathematics is one of the basic subjects at all levels of education. Ministries of education in various countries of the world pay great attention to developing balanced and comprehensive mathematics curricula. Therefore, the process of analyzing mathematics textbook curricula for all grades from first to twelfth is an important process that aims to achieve balance and development in the curricula in line with modern learning standards and educational development plans. It also aims to classify the type of exercises and the number of repetitions, in addition to studying teachers' opinions and their evaluation of the content.

2. Statement of the Problem

There are signs of differences in how mathematical topics such as algebra, geometry, and statistics are distributed throughout various educational levels, even though the Sultanate of Oman has made strides in creating mathematics curricula. Students' learning sequence and profound comprehension of mathematical abilities may be impacted by this discrepancy. Therefore, a statistical analysis of the mathematical content's balance in terms of page count, frequency, and exercise type is required.

3. Aims of The Study

This study aims to:

1. Analyze the distribution of algebra, geometry, and statistics contents in mathematics textbooks from grades 1 to 12 in Sultanate of Oman.

2. Discover the extent to which statistics are included in mathematics textbooks.

3. investigating the statistical concepts and skills in Oman mathematics text books.

4. Identify teachers' opinions on challenges and suggestions in the statistical content.

4. The questions of the study

1. How widely distributed are algebra, geometry, and statistics units in mathematics textbooks for all grades (from grade1 to grade 12) in the Sultanate of Oman?

2. How frequently do statistical concepts appear in mathematics textbooks?

3. What types of statistical questions are included? Are they cognitive, applied, or deductive in nature?

4. What is the teachers' assessment of the content of mathematics textbooks in general, and statistics in particular?
5. Are there any statistically significant differences in teachers' assessments based on gender, age, and number of years of teaching experience?

5. Significance of the Study

The significance of this study resides in its capacity to accurately depict how fundamental mathematical topics are distributed throughout textbooks, assisting in the identification of the advantages and disadvantages of the current curriculum framework. It will ensure aligns with educational goals, supports effective teaching and learning, and improves student achievement. It helps identify strengths and weaknesses, guides curriculum development and reforms, ensures cultural relevance, and promotes accountability. It enhances the quality and effectiveness of math education. Its conclusions also help educational decision-makers create curriculum and present content in a balanced manner that complies with international standards.

6. limitations of the Study

This study was limited to analyzing mathematics textbooks for all grades issued by the Ministry of Education in the Sultanate of Oman for the 2024/2025 academic year. It also included a questionnaire on the opinions of a sample of teachers working in government schools.

7. Literature Review

In this section, we give a brief look at the studies related to our study.

Al Kurdi, F. K. (2024) examined Grade 7–8 textbooks, highlighting significant variation in coverage of Common Core statistical standards; e.g., tree-diagram representations were well-covered (39.5%), while simulation-based sampling was entirely absent

Al-Kindi (2020) carried out a study in the Sultanate of Oman included questionnaires for a number of mathematics teachers. The results showed that 62% of teachers believe that statistics are insufficient, while others, including 78% of teachers, believe that the sequence of concepts is illogical between grade

Al-Shammari (2019) analyzed Saudi middle school mathematics textbooks and found that algebra accounted for 45% of the total, geometry 30%, and statistics 25%.

Ali and Weston (2018) studied the UK mathematics textbooks and showed large variations in the distribution of algebra and geometry across grades, with the percentage of statistics rising significantly in secondary school.

Yilmaz's (2017) analyzed questions in Turkish mathematics textbooks and found that 70% were cognitive and 10% were deductive.

Abdul (2015) conducted a study that aimed to investigate the extent to which the content of data analysis and probability in mathematics textbooks for the fourth through sixth grades in Jordan conformed to the National Mathematical Standards Institute (NCTM) for the year 2000. The results revealed that the overall score for the availability of these standards was 23.64% for the fourth grade, 40.0% for the fifth grade, and 47.27% for the sixth grade.

Ryan (2014) analyzed the content of mathematics books for the eighth grade in Palestine, and found that geometry represented 47.27%, algebra 35.35%, and statistics 17.38%. It also showed that all cognitive levels were achieved in the eighth-grade mathematics book at varying rates. The knowledge level was 49.89%, while application was 36.27%, and reasoning was 13.84%.

Al-Zoabi and Al-Obaida (2014) analyzed the content of mathematics books for the fourth-grade in the Saudi Arabia include elements of numeracy and operations, with percentages ranging from (2.03% to 14.5%), geometry (6.42% to 13.58%), data analysis and probability (6.98% to 15.12%), problem-solving (9.41% to 28.24%), logical thinking and proof (5.17% to 15.52%), and communication (4.30% to 25.81%).

Nassar (2011) studied extent to which the algebraic concepts included in the Palestinian mathematics curriculum for the upper primary stage conformed to the NCTM standards. The researcher used a descriptive-analytical approach. The sample consisted of grades 6-8, as well as 396 teachers. The results showed that the percentage of algebraic concepts from the NCTM standards was 66.82% in the sixth grade, 64.39% in the seventh grade, and 63.68% in the eighth grade.

8. Content analysis of Math Textbooks

We analyzed mathematics textbooks from grades 1 to 12, dividing them into three sections: algebra, geometry, and statistics. We compared them based on page count and percentages, and using SPSS, we conducted a chi-square test for page count. From the statistics section, we collected concepts, lessons, and graphs, and number of exercises and activities dividing them according to the Bloom-Levels, and also examined the extent to which they included knowledge economy skills.

Table 1 shows that for the statistics section, the number of pages was lower in advanced grade 12 at 0 pages, and higher in grade 10, at 147 pages (44.14%). For the algebra section, we found that the number of pages was higher in grade 9, at 292 pages (66.06%), and lower in grade 2, at 56 pages (75.67%). For the geometric section, we found that the number of pages was higher in grade 9, at 136 pages (30.76%), and lower in basic grade 11 and 12, at 0 . From the total number of pages, the algebra came in first place, then geometry, and then statistics. This made it clear to us that statistics lessons are distributed poorly in the school grades compared to algebra and geometry

Table 1 Number of pages and percentages of algebra, geometry, and statistics in the textbooks.

	Algebra		**Geometry**		**Statistics**	
Grade	**Number of pages**	**Percentage**	**Number of pages**	**Percentage**	**Number of pages**	**Percentage**
1	66	%476.7	14	16.27%	6	6.97%
2	56	75.67%	14	18.91%	4	5.40%
3	105	77.77%	22	16.29%	8	5.92%
4	66	61.11%	12	11.11%	30	27.77%
5	82	65.07%	30	23.80%	14	11.11%
6	85	64.39%	35	26.51%	12	9.09%
7	162	58.69%	62	22.46%	52	18.84%
8	153	64.2%	41	17.2%	44	18.4%
9	292	66.06%	136	30.76%	14	3.16%
10	101	30.33%	85	25.52%	147	44.14%
11	165	49.84%	66	22.53%	62	21.16%
12	252	77.06%	32	11.27%	0	0
	1519	**61.72%**	**549**	**22.31%**	**393**	**15.97%**

Table 2 presents the results of the chi-square test, which compares the expected and observed frequencies for the number of pages dedicated to algebra, geometry, and statistics across grades 1 to 12. This test was employed to determine whether the distribution of content among the three sections significantly varies across different grade levels or if it occurs randomly without intentional design. As shown in Table 2, the significance values are below the threshold of 0.05. Therefore, the content distribution across the three sections is not uniform in the mathematics textbooks.

Table 2 Chi-square test to test the equality of the frequencies of the three components for all grades

Grade		ALGEBRA	GEOMETRY	STATISTICS	Chi-square	p-value
1	Observed	66	14	6	74.047	0.000
	Expected	28.7	28.7	28.7		
2	Observed	56	14	4	61.730	0.000
	Expected	24.7	24.7	24.7		
3	Observed	105	22	8	122.178	0.000
	Expected	45	45	45		
4	Observed	66	12	30	42.000	0.000
	Expected	36	36	36		
5	Observed	82	30	14	60.190	0.000
	Expected	42.0	42.0	42.0		
6	Observed	85	35	12	63.318	0.000
	Expected	44.0	44.0	44.0		
7	Observed	162	92	70	80.435	0.000
	Expected	92.0	92.0	92.0		
8	Observed	135	41	44	102.664	0.000
	Expected	79.3	79.3	79.3		
9	Observed	292	136	14	263.584	0.000
	Expected	147.3	147.3	147.3		
10	Observed	101	85	147	18.667	0.000
	Expected	111	111	111		
11	Observed	165	66	62	69.713	0.000
	Expected	97.7	97.7	97.7		
12	Observed	252	32	0	170.423	0.000
	Expected	142.0	142.0	142.0		

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9. Statistical concepts and Skills

The term concept refers to a fundamental and abstract idea that forms the basis for understanding a subject and directs the learning process. Within the field of statistics, a concept embodies a core principle or theoretical framework that enables the comprehension, analysis, interpretation, and inference of data. Conversely, skill denotes the developed capability to execute tasks or activities effectively and efficiently, acquired through education, practice, and experience. In the context of statistics, skill refers to the practical proficiency in applying statistical concepts, methodologies, and tools to accurately collect, analyze, interpret, and communicate data-driven insights.

Mathematics textbooks present statistical concepts as foundational principles that facilitate students' understanding and interpretation of data. These concepts encompass data types, variables, measures of central tendency and dispersion, graphical representations, probability, data distribution, correlation, and sampling. Furthermore, these textbooks emphasize the development of statistical skills—practical competencies that include data collection, organization, and analysis; creation and interpretation of graphs; calculation of statistical measures; application of statistics to solve real-world problems; and clear communication of findings, often supported by technological tools.

The statistical concepts and skills in the mathematics textbooks in sultanate of Oman are summarized as follows:

Grades (1 to 4):

Students in Grades 1 to 4 are introduced to fundamental statistical concepts such as Carroll charts and Venn diagrams. While probability lessons are not formally included at this stage, statistics lessons focus on foundational skills. These include collecting and classifying data, organizing data, creating and interpreting counting tables, and using tables to display data. Additionally, students learn to represent data using pictures and cubes, and to make comparisons between data sets.

Grades (5 to 9):

In Grades 5 to 9, students encounter a wider range of statistical concepts. These include mode, line graphs, column graphs, frequency, frequency tables, pie charts, mean, arithmetic mean, range, median, conversion tables, and a variety of probability-related terms such as opportunity, equal probability, random, mutually exclusive events, and both theoretical and experimental probability. They are also introduced to discrete and continuous data, modal class, grouped frequency tables, class intervals, central tendency, double frequency tables, frequency polygons, patterns, midpoints, and various set theory concepts such as sets, empty set, universal set, complement, union, intersection, subsets, and Venn diagrams. The "Distinctive Adjective Formula" is also introduced.

Probability lessons for these grades include understanding and calculating probability, identifying definite and unlikely possibilities, exploring equal and impossible probabilities, recognizing the probability of events not occurring, analyzing equally likely outcomes, and working with possibility spaces and empirical versus theoretical probabilities.

Statistics lessons build upon earlier skills with increased complexity. Students continue to collect and classify data, organize it using frequency tables, and draw line graphs. They use pie charts and line charts for data display, work with statistical metrics, analyze data for two variables (such as scatter plots), and learn about histograms and various statistical calculations. They also practice interpreting and drawing frequency charts and polygons, comparing distributions, drawing conclusions, and understanding general set concepts including Venn diagrams and the "Distinctive Adjective Formula."

Grade 10:

At Grade 10, students explore more advanced statistical concepts, including qualitative, numerical, and quantitative data; primary and secondary data; and more complex data visualizations such as two-way tables, pictograms, bar graphs, pie charts, and line graphs. They also engage with steam-and-leaf diagrams, grouped data, discrete and continuous data, estimated means, modal class, percentiles, quartiles, boxplots, and correlation concepts. They study bivariate data, scatter diagrams, interquartile ranges, and understand variables such as dependent variables, positive/negative/no correlation, trends, and lines of best fit. Other statistical topics include extrapolation, histograms, frequency density, cumulative frequency tables and curves, and basic probability concepts such as event, trial, experimental and theoretical probability, favorable outcomes, bias, possibility diagrams, and sample spaces. Conditional probability and combined events are also introduced.

Probability lessons in Grade 10 include an introduction to probability, using probability space diagrams, analyzing independent and mutually exclusive events, and utilizing tree diagrams and Venn diagrams to calculate probability, including conditional probability.

In statistics, students refine their ability to collect and classify data using counting and frequency tables, stem-and-leaf diagrams, and double tables. They display data using picture and bar representations, double bar charts, pie charts, and line graphs. The curriculum also includes the use of percentiles, quartiles, and box plots; analysis of two-variable data; use of histograms; and cumulative frequency analysis.

Grades 11 and 12:

In Grades 11 and 12, students delve into high-level statistical concepts, including central tendency, coded data, mean, variance, standard deviation, and various types of probability distributions. These include expectation, discrete random variables, mathematical models, normal distribution, geometric distribution, grouped and ungrouped data, interquartile range, and binomial distribution. They study the mode and deepen their understanding of probability distribution, expectation, and variance.

Probability lessons emphasize using permutations and combinations in probability, working with discrete random variables, calculating the expected value and variance of discrete variables, and analyzing their probability distributions.

Statistics lessons at this stage include arithmetic mean, variance, standard deviation, binomial distribution, and the expectancy and variance of binomial and geometric distributions. Students also explore prediction using geometric distributions, range calculations for grouped and non-aggregated data, and characteristics of dispersion metrics. Advanced topics such as normal distribution, continuous random variables, probability density functions (PDF), normal curves, standard normal variables, and Z-scores are covered. Students learn how to convert normal distributions to standard form and use them to calculate probabilities.

During the review of mathematics textbooks utilized in the Sultanate of Oman, Grade 10 contains the highest concentration of statistical content, encompassing a total of 61 concepts. This aligns with the understanding that advanced grade levels are the most suitable for introducing a comprehensive array of statistical concepts and skills, given that students at this stage possess the requisite mathematical and analytical maturity to grasp more complex topics. Moreover, the curriculum at this level effectively prepares students for university-level statistics.

In contrast, Grade 2 does not include any statistical concepts, while Grade 4 introduces two foundational concepts: the Carroll diagram and the Venn diagram—both of which are also revisited in Grades 1 and 3. Additionally, probability lessons are absent from Grades 1 through 4, reflecting the recognition that the concept of probability is too advanced for students in these early stages of education.

Every book from grades 7 to 12 includes "General Terms" at the end and "Lesson Concepts" at the beginning of each unit. Some include terms with definitions, while others do not. In some books, such as those for grades 1-6, all statistical concepts were in Arabic, but in grades 7-12, an English translation was added for each statistical concept found at the beginning of each unit and at the end of the book. Also, in grades 11 and 12, the unit's name and some words between the lines are added in English, which is good for students, as they have prior knowledge of the English concepts.

Regarding the charts, grades 1-4 consider simple charts, such as (pictograms, Carroll charts, counting tables, and Venn diagrams), new charts were added for grades 5-9 such as tree diagram, pie chart, bar chart, histogram and line graph based on the previous charts but with more complex exercises. More advanced charts were added for grades 10-12 like steam and leaf diagram, box chart, double bar graph and dot graph.

47.05% of statistics unit is for data collection and representation while 29.41% is for statistical metrics and the remaining 23.52% is for probability.

10. Statistical exercises and activities

The questions and exercises included in mathematics textbooks were analyzed using Bloom's levels (remembering, understanding, applying, analyzing, evaluating, and creating). The results are shown in Tables 3. Differences in the distribution of questions for the first grades (grades 1-4) were observed. The focus was more on creativity and innovation, such as (create, draw, color, and design your own chart) to motivate students. Application questions began to increase in frequency after the seventh grade. In the eighth grade, there was a variety in the types of questions, but the focus was more on comprehension and knowledge questions. In the ninth grade, there was a greater emphasis on application questions compared to other questions .Likewise, in the tenth grade, there was a greater emphasis on application questions, and there was a variety in the remaining types of questions. In grades 11 and 12, there were many applications and analysis questions, and there was competition between them. Some of the questions included a combination of analysis and application, but application was considered the highest.

Table 3 Number of the exercises and activities related to statistics.

Grade	**exercises**	**Activates**	**Grade**	**exercises**	**Activates**
1	9	1	7	90	83
2	3	6	8	71	54
3	10	2	9	24	9
4	23	19	10	150	107
5	26	25	11	163	91
6	9	25	12	96	98

We investigate the number of exercises and activities included in the statistics units. As indicated in Table 2, the number of pages dedicated to statistics is lower compared to algebra and geometry, which naturally results in fewer exercises and activities in the statistics sections. Table 3 presents a comparison between the number of activities in the activity book and the number of exercises in the student book, revealing that the activities are fewer in number. This observation aligns with feedback from several teachers in the questionnaire, who expressed a desire to see an increase in the number of activities included in the activity book.

The table shows significant variation in the number of exercises and activities included in the statistics units across different grade levels.

Grades (1–6):

In the early grades, there is a relatively modest number of exercises and activities. Notably, Grades 5 and 6 have a higher number of activities (25 each), and Grade 5 has the highest number of exercises (26) among Grades 1–6. However, some inconsistencies appear — for example, Grade 2 has more activities (6) than exercises (3), while Grade 6 has nearly three times more activities (25) than exercises (9), suggesting a greater emphasis on practical engagement in these specific grades.

Grades (7–12):

The number of exercises increases significantly in Grades 7 to 12, peaking in Grade 11 with **163 exercises**, followed by Grade 10 with **150 exercises**. Activities also rise in quantity, although they remain consistently fewer than exercises in all upper-grade levels. For example, Grade 10 includes 107 activities compared to 150 exercises, and Grade 11 includes 91 activities versus 163 exercises.

Overall**,** Exercises consistently outnumber activities across all grades, with a much sharper increase in higher grades. The gap between exercises and activities becomes particularly large in Grades 9 and 11. For instance, in Grade 9, there are 24 exercises and only 9 activities, suggesting a more theoretical focus. The distribution pattern supports feedback from educators, as mentioned earlier, that there is a relative shortage of activities compared to exercises — particularly in middle and high school levels — and reinforces the suggestion to increase the number of activities to better balance conceptual understanding with hands-on learning.

Table 4 Bloom's basic levels in statistical exercises

Grade	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	0	2	2	2	0	0
2	0	4	0	0	0	2
3	0	9	0	0	0	4
4	0	6	7	5	0	8
5	0	8	3	3	4	1
6	3	1	6	3	0	0
7	2	19	62	15	16	3
8	1	20	35	7	4	4
9	0	18	2	2	2	2
10	6	16	110	8	4	6
11	0	17	134	58	20	2
12	0	11	37	8	6	1

Table 4 presents the distribution across Bloom's six cognitive levels; Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating, for Grades 1 through 12.

There is a clear progression in cognitive demand from lower to higher grade levels.

- Grades (1–6) are mostly focused on understanding and low-order skills, while higher grades (7–12) show a strong emphasis on applying and analyzing.
- The "Applying" category dominates from Grade 7 onward, indicating a curriculum shift toward practical engagement and real-world statistical thinking.

Grades (1–6)

- These grades primarily target Understanding (e.g., Grade 3: 9; Grade 5: 8) and have very few to no items in Analyzing, Evaluating, or Creating.
- Creating-level tasks are minimal but start to appear in Grade 2 and increase slightly in Grades 3–5 (e.g., Grade 4: 8).
- Remembering is almost absent except in Grades 6 (3 exercises) and 2 (0 exercises).

This indicates that the early years focus more on conceptual comprehension and gradual introduction of basic application tasks.

Grades (7–9)

- A significant shift occurs at Grade 7, with a sharp rise in Applying tasks (62), followed by continued strength in Grade 8 (35).
- Analyzing and Evaluating also begin to appear prominently at Grade 7 (15 and 16, respectively).
- Grade 9 marks a slight dip in Applying (only 2), suggesting possible content or curriculum transition at this level.

This phase shows a clear pedagogical intention to increase higher-order thinking, with learners engaging more in applying knowledge and beginning to critically assess data.

Grades (10–12)

- The highest number of Applying-level exercises is seen in Grades 10 and 11 (110 and 134, respectively), making this the dominant skill level.
- Analyzing becomes highly emphasized in Grade 11 (58), while Evaluating and Creating are also present (20 and 2, respectively).
- Grade 12 maintains a relatively balanced presence across Applying (37), Analyzing (8), and Evaluating (6), though Creating is still minimal (1).

These patterns suggest that the upper secondary curriculum is strongly focused on practical application, data analysis, and critical evaluation, with limited emphasis on creative or open-ended tasks.

- Applying is the most emphasized skill from Grade 7 onwards, peaking in Grades 10 and 11.
- Higher-order thinking skills (Analyzing, Evaluating, and Creating) appear gradually and become more prominent in the later grades, especially Grade 11.
- Creative tasks (Creating level) remain rare across all grades, indicating a potential area for enrichment if the goal is to foster innovation or original problem-solving.

11. Analysis of Teachers Feedback

Statistics are increasingly recognized as essential fields. Developing students' statistical thinking should start early and continue through high school. To support this, teachers need strong statistical knowledge and an understanding of how students learn statistics. Teachers at the secondary level must also guide students in computational and data-driven thinking. Therefore, high-quality teacher preparation and professional development—both before and during teaching careers—are crucial. This training must also emphasize equity and critical data literacy.

A survey was conducted using a structured questionnaire to gather data from mathematics teachers regarding their opinions, suggestions, and concerns about the mathematics curriculum, with a specific focus on the inclusion of statistics. Data analysis was conducted using the SPSS software.

The sample comprised 54.29% female and 45.71% male teachers. In terms of teaching experience, 45.71% of the participants had less than 5 years of experience, 8.57% had between 5 and 10 years, and 45.71% had more than 10 years of experience. Teachers were also categorized by instructional level: **20%** taught grades 1–4, 42.86% taught grades 5–9, and 37.14% taught grades 10–12.

From the teachers' responses, 25.71% of the participant received specialized training in teaching statistics whereas 74.29% have not received specialized training in teaching statistics.

Table 5 Challenges in teaching statistics from teacher perspective.

Challenges	percentages
Difficulty in students understanding statistical terminology	31.4%
Difficulty presenting content in an attractive way	31.4%
Lack of time allocated for teaching statistics	54.3%
lack of educational resources	42.9%

The data reflects the main challenges faced by mathematics teachers when teaching statistics, based on their self-reported responses: **54.3% of teachers** indicated that the **lack of time allocated** for teaching statistics is a major obstacle. This suggests that curriculum constraints or scheduling issues significantly hinder teachers' ability to adequately cover statistical content. **42.9% of teachers** reported a **lack of educational resources**. This highlights a need for better instructional support materials to facilitate effective teaching. **31.4% of teachers** noted that students experience **difficulty in understanding statistical terminology**. This points to a cognitive or linguistic barrier that may require more scaffolded instruction or simplified explanations. Another **31.4% of teachers** expressed challenges in **presenting statistical content in an engaging or attractive way**. This suggests a pedagogical gap, where teachers may benefit from professional development on innovative or student-centered teaching strategies. The findings reveal that the most pressing issue is **insufficient instructional time**, followed by **limited resources**, while challenges related to **student comprehension** and **instructional delivery** are also significant. These insights underscore the need for curriculum adjustments, enhanced resource provision, and targeted training for teachers to improve the teaching and learning of statistics.

12. Hypotheses Testing

1.1.1.1.1 12.1 The First Hypothesis

The first null hypothesis says: There are no significant differences in responses across the three teaching levels

Since the sample sizes are small, normality of the data was checked. The hypothesis in testing normality is that " The data are normally distributed". Normality test helps assess if parametric tests (which assume normality) can be applied to the data. Many parametric tests (like t-tests, ANOVA) assume that data are normally distributed. Non-normal data might require the use of non-parametric tests (like Mann–Whitney U, Kruskal–Wallis).

Normality tests are used to assess whether a dataset follows a normal distribution. Common tests include the Shapiro-Wilk test, which is highly recommended for small to medium sample sizes ($n < 2000$) due to its power and sensitivity, and the Kolmogorov-Smirnov (K-S) test, a general-purpose test that compares the sample distribution to a reference distribution. The Lilliefors test is a modification of the K-S test for cases where the population mean and variance are not known. The Anderson-Darling test gives more emphasis to the tails of the distribution, making it effective for detecting deviations in extreme values. The Jarque-Bera test and D'Agostino's K^2 test are based on skewness and kurtosis and are often used for larger samples. Other tests based on moments include separate skewness and kurtosis tests, as well as the D'Agostino-Pearson test, which combines both. In addition to statistical tests, visual tools like histograms, Q-Q plots, P-P plots, and boxplots are often used to assess normality by observing the shape, symmetry, and presence of outliers in the data. For more details see Shapiro, S. S., & Wilk, M. B. (1965), Smirnov, N. V. (1948)., Lilliefors, H. W. (1967), Anderson, T. W., & Darling, D. A. (1954), Jarque, C. M., & Bera, A. K. (1980), D'Agostino, R. B. (1971), D'Agostino, R. B., & Pearson, E. S. (1973) and Joanes, D. N., & Gill, C. A. (1998).

In this study, the five questions were subjected to Shapiro-Wilk test which is available in SPSS program. The outcomes of Shapiro-Wilk test are summarized in Table 6. The **table** reports the normality test results across three teaching levels with sample sizes of 7, 14, and 14 respectively. The results show that some questions retain non-normal distributions while others approximate normality. Therefore, the normality assumption is preached and hence Kruskal -Wallis test is used.

The **Kruskal–Wallis H test** is a **non-**parametric statistical test used to determine whether there are statistically significant differences between the medians of three or more independent groups. It is the non-parametric alternative to the one-way ANOVA and is used when the assumptions of normality or equal variances are not met.

The assumptions of this test are: the samples are independent, the data are at least ordinal, the distributions of the groups have a similar shape (though not necessarily normal) and the observations are randomly sampled.

The test procedure starts by ranking all the data from all groups together and then compares the mean ranks between groups. For details see **Kruskal, W. H., & Wallis, W. A.** (1952).

The outcomes of the **Kruskal–Wallis test** are summarized in Table 7. All p-values are above 0.05, leading us to not rejecting the null hypothesis. Therefore, no significant differences exist between teaching levels on any of the five questions.

Table 6 The results of Shapiro-Wilk test of normality of the 5 questions for the 3 teaching levels

Questions	level	Test statistic	p-value
To what extent do mathematics courses include lessons in statistics and probability?	1-4	.887	**.262**
	5-9	.794	.004
	10-12	.862	.032
How do you evaluate students' understanding of statistics concepts after teaching them?	1-4	.833	**.086**
	5-9	.801	.005
	10-12	.796	.005
Do you think the school curriculum provides sufficient coverage of statistics topics?	1-4	.894	**.294**
	5-9	.862	.032
	10-12	.874	.049
Does the teacher's guide help in teaching statistics and probability?	1-4	.869	**.183**
	5-9	.889	**.079**
	10-12	.835	.014
The extent to which the emotional aspect is included in teaching statistics	1-4	.453	.000
	5-9	.825	.010
	10-12	.795	.004

Table 7 The outcomes of Kruskal Wallis test to test the significance differences between the teaching levels on responding to the 5 questions.

Questions	Test statistic	p-value
To what extent do mathematics courses include lessons in statistics and probability?	7.579	**.023**
How do you evaluate students' understanding of statistics concepts after teaching them?	.442	.802
Do you think the school curriculum provides sufficient coverage of statistics topics?	1.291	.524
Does the teacher's guide help in teaching statistics and probability?	4.857	.088
The extent to which the emotional aspect is included in teaching statistics	3.959	.138

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1.1.1.1.2 12.2 The Second Hypothesis

The second null hypothesis says: There are no significant differences in responses across the three experiences level of teaching

As the sample sizes are small, normality was checked using Shapiro-Wilk test and the outcomes are summarized in Table 8. The **table** shows the normality test outcomes across the three experiences level with sample sizes of 16, 3, and 16. The results show that some questions retain non-normal distributions while others approximately normal. Hence, the normality assumption is violated and so Kruskal -Wallis test is used. The outcomes are shown in Table 9. All p-values are above 0.05, leading us to failing to reject the null hypothesis. Therefore, no significant differences exist between teaching levels on any of the five questions.

Table 8 The results of Shapiro-Wilk test of normality for the 5 questions at 3 experience levels

Questions	level	Test statistic	p-value
To what extent do mathematics courses include lessons in statistics and probability?	< 5	.861	.020
	5-10	1.000	1.000
	>10	.819	.005
How do you evaluate students' understanding of statistics concepts after teaching them?	< 5	.748	.001
	5-10	.964	.637
	>10	.793	.002
Do you think the school curriculum provides sufficient coverage of statistics topics?	< 5	.883	.043
	5-10	.964	.637
	>10	.856	.017
Does the teacher's guide help in teaching statistics and probability?	< 5	.831	.007
	5-10	.964	.637
	>10	.886	.049
The extent to which the emotional aspect is included in teaching statistics	< 5	.839	.009
	5-10	.964	.637
	>10	.684	.000

Table 9 The outcomes of Kruskal Wallis test to test the significance differences between the experience levels on responding to the 5 questions.

Questions	Test statistic	p-value
To what extent do mathematics courses include lessons in statistics and probability?	.624	.732
How do you evaluate students' understanding of statistics concepts after teaching them?	5.404	.067
Do you think the school curriculum provides sufficient coverage of statistics topics?	.472	.790
Does the teacher's guide help in teaching statistics and probability?	.090	.956
The extent to which the emotional aspect is included in teaching statistics	.634	.728

1.1.1.1.3 12.3 The Third Hypothesis

The third null hypothesis says: There are no significant differences between males and females on their responses to the 5 questions

As the sample sizes are small, normality using Shapiro-Wilk test is used and the outcomes are summarized in Table 10. The **table** demonstrates the normality test outcomes for both males and females with small sample sizes. For **all five questions**, the responses of both male and female teachers **do not follow a normal distribution**, as all p-values are below 0.05. Hence, the normality assumption is violated so Mann-Whitney test is more appropriate for analyzing differences between groups.

The **Mann–Whitney U test** is a **non-parametric test** used to compare **differences between two independent groups** when the data **does not meet the assumptions of normality.** It is the non-parametric alternative to the **independent samples t-test**. The assumptions of the **Mann–Whitney test** are: observations are independent within and across groups, the dependent variable is ordinal or continuous and the distributions of the two groups are similarly shaped.

The procedure of the test begins by ranking together all observations from both groups, the U statistic is calculated based on the sum of ranks in each group. The test assesses whether one group tends to have higher or lower values than the other. For details see Mann, H. B., & Whitney, D. R**.** (1947).

The outcomes of Mann Whitney are shown in Table 11. It shows that all p-values are above 0.05, leading to accept the null hypothesis. Therefore, no significant differences exist between teaching levels on any of the five questions.

Table 10 Normality test of the responses of the 5 questions for males and females.

Questions	Gender	Test statistic	p-value
To what extent do mathematics courses include lessons in statistics and probability?	female	.899	.047
	male	.760	.001
How do you evaluate students' understanding of statistics concepts after teaching them?	female	.803	.001
	male	.788	.002
Do you think the school curriculum provides sufficient coverage of statistics topics?	female	.877	.019
	male	.869	.027
Does the teacher's guide help in teaching statistics and probability?	female	.855	.008
	male	.886	.049
The extent to which the emotional aspect is included in teaching statistics	female	.806	.001
	male	.728	.000

Table 11 The outcomes of Mann-Whitney test to test the significance differences between the males and females on responding to the 5 questions.

Questions	Test statistic	p-value
To what extent do mathematics courses include lessons in statistics and probability?	113.5	.205
How do you evaluate students' understanding of statistics concepts after teaching them?	133	.545
Do you think the school curriculum provides sufficient coverage of statistics topics?	111	.182
Does the teacher's guide help in teaching statistics and probability?	147	.883
The extent to which the emotional aspect is included in teaching statistics	115	.230

The Mann-Whitney U test was conducted to determine whether there are statistically significant differences between male and female teachers in their responses to the five questions related to statistics education. The test is appropriate for comparing two independent groups (males and females) when the data may not follow a normal distribution. As shown in **Table 11**, all p-values are **greater than 0.05**, indicating that **none of the observed differences in responses between male and female teachers are statistically significant.**

13. Size effect

The **Eta** (η) and **Eta squared** (η^2) are measures of **association** and **effect size**. They indicate how strongly a categorical independent variable is associated with a continuous dependent variable. A **correlation ratio** used to measure **the strength of association** between a nominal (categorical) independent variable and a dependent variable. **Eta squared (η^2) Indicates the proportion of total variance in the dependent variable that is explained by the independent variable.**

When $\eta^2 = 0.01$**, then the effect size is small while when** $\eta^2 = 0.06$**, then the effect size is medium and when** $\eta^2 \geq 0.14$**, then the effect size is large. For more details, see Cohen, J.** (1988), **Richardson, J. T. E.** (2011) and **Pierce, C. A., Block, R. A., & Aguinis, H.** (2004).

The Eta measure used, where Eta represents the correlation coefficient between the (teaching level, teaching experience level and gander) on the 5 questions and Eta Square determine the size of the effect.

Table 12 Eta (η) and eta square (η^2) measurements for level of teaching, gender and experience

	Level		Gender		Experience	
	η	η^2	η	η^2	η	η^2
To what extent do mathematics courses include lessons in statistics and probability?	.514	.264	.280	.079	.114	.013
How do you evaluate students' understanding of statistics concepts after teaching them?	.103	.011	.113	.013	.372	.138
Do you think the school curriculum provides sufficient coverage of statistics topics?	.185	.034	.238	.057	.106	.011

Does the teacher's guide help in teaching statistics and probability?	.360	.130	.038	.001	.040	.002
The extent to which the emotional aspect is included in teaching statistics	.329	.108	.232	.054	.088	.008

Table 12 presents **Eta** (η) and **Eta squared** (η^2) values, which are measures of association between categorical independent variables (teaching level, gender, experience) and responses to questions about statistics education.

1- For the question "**To what extent do mathematics courses include lessons in statistics and probability?" teaching level demonstrates** the strongest effect ($\eta = 0.514 , \eta^2 = 0.264$)**, Gender** ($\eta = 0.280 , \eta^2 = 0.079$) has medium effect and **experience** ($\eta = 0.114 , \eta^2 = 0.013$) have small effects. These findings suggest that educational level significantly influences perceptions of how thoroughly statistics and probability are integrated into mathematics courses.

2- Regarding the question "**How do you evaluate students' understanding of statistics concepts after teaching them?" experience** ($\eta = 0.372 , \eta^2 = 0.138$) exhibits a large effect. In contrast, both teaching l**evel** ($\eta = 0.103 , \eta^2 = 0.011$) **and Gender** ($\eta = 0.113 , \eta^2 = 0.013$) have minimal effects. This indicates that years of teaching experience play a key role in shaping teachers' evaluation methods for students' understanding of statistical concepts.

3- For the question "**Do you think the school curriculum provides sufficient coverage of statistics topics?**" teaching l**evel** ($\eta = 0.185 , \eta^2 = 0.034$)**, Gender** ($\eta = 0.238 , \eta^2 = 0.057$) and **experience** ($\eta = 0.106 , \eta^2 = 0.011$) show **small effects**. No strong relationship between any demographic factor and teachers' views on curriculum sufficiency in statistics coverage.

4- In response to the question "**Does the teacher's guide help in teaching statistics and probability?" teaching level** has the medium effect ($\eta = 0.360 , \eta^2 = 0.130$) **while Gender** ($\eta = 0.038 , \eta^2 = 0.001$) and **experience** ($\eta = 0.040 , \eta^2 = 0.002$) have very small effects. This implies that educational level may influence how teachers perceive the usefulness of the teacher's guide, whereas gender and experience appear to have minimal impact.

5- For the question "**The extent to which the emotional aspect is included in teaching statistics?" teaching level** ($\eta = 0.329 , \eta^2 = 0.108$) **has medium effect while Gender** ($\eta = 0.232 , \eta^2 = 0.054$) and **experience** ($\eta = 0.088 , \eta^2 = 0.008$) show **small to negligible effects**. There is limited variance in opinion about the emotional aspect based on demographic characteristics.

1.1.2 14. Teachers' Suggestions for Improving the Teaching of Statistics

Based on the perspectives of the mathematics teachers, the following recommendations are proposed to enhance the effectiveness of statistics instruction and curriculum development:

1) Curriculum and Content Development

1) Increase the number of lessons dedicated to statistical concepts.
2) Reduce curriculum load and distribute it more evenly.
3) Revise the curriculum to link statistics topics with environmental and societal contexts.
4) Present statistical concepts in a simplified and gradual manner.
5) Teach statistics as an independent subject during one academic semester.
6) Emphasize core concepts and avoid overwhelming students with technical details.

2) Real-Life Relevance

1) Connect statistical concepts to real-life applications and daily experiences.
2) Provide realistic examples and problem-solving tasks to help students understand the importance of statistics.
3) Utilize data from the local community in class activities.
4) Organize field trips to institutions that apply statistics in real-world contexts.

3) Teaching Methods and Learning Environment

1) Use technology and interactive software to clarify statistical ideas.
2) Provide adequate teaching tools and resources in the classroom.
3) Allocate sufficient time for statistics classes to allow for hands-on practice.
4) Diversify educational resources to present content in an engaging and accessible way.
5) Encourage group work and collaborative learning when solving statistical problems.

4) Professional Development and Teacher Support

1) Offer specialized training courses in teaching statistics.
2) Train teachers in modern instructional strategies that accommodate diverse student needs.
3) Provide access to educational applications and software that support effective teaching of statistics.

5) Assessment and Question Design

1) Ensure assessment questions are clear in both data provided and what is being asked.
2) Design lessons around a central, well-defined concept that guides related questions and activities.
3) Use examples with realistic, manageable numbers and include ready-made graphs to support understanding.

Conclusion

Based on the findings of this study, an in-depth analysis was conducted on the content of the prescribed mathematics textbooks used in the Sultanate of Oman from grades one through twelve. The objective was to evaluate the extent to which fundamental mathematical concepts—namely mathematics, algebra, geometry, and statistics—were distributed in a balanced manner. The analysis also assessed the quality of exercises, the frequency of lessons, and the integration of knowledge economy skills.

The results revealed a significant disparity in content distribution across grade levels, with algebra and geometry receiving greater emphasis compared to statistics, which was underrepresented in terms of page allocation, lesson frequency, and skill development. Furthermore, the majority of statistical exercises were found to be predominantly cognitive, with limited focus on applied or inferential questions, potentially impeding the development of higher-order thinking skills among students.

To analyze teachers' perceptions, non-parametric statistical tests such as the Mann-Whitney U and Kruskal-Wallis tests were applied to questionnaire responses. The findings indicated statistically significant differences in teachers' evaluations of textbook content based on age and gender.

Overall, the analysis highlighted the need to revise and enrich the current curriculum to align with international standards and to better foster essential skills such as creativity, critical thinking, problem-solving, and cognitive integration. The study also addressed the degree to which knowledge economy skills are embedded within the curriculum.

To strengthen the outcomes of this study and inform future curriculum development, we recommend the followings:

Statistical content should be incorporated alongside algebra and geometry, particularly in the upper grade levels. Sufficient instructional time must be dedicated to ensure thorough coverage of statistical topics. Moreover, introducing essential statistical terminology in both Arabic and English will better prepare students for higher education, particularly in settings where English is the medium of instruction.

It is also important to enhance both the quantity and quality of statistical exercises and practical activities in student textbooks and workbooks. These should include more applied and analytical tasks to foster critical thinking and real-world problem-solving abilities.

The curriculum should be revised to promote essential 21st-century skills such as creativity, digital literacy, and problem-solving—key competencies for success in a knowledge-based economy.

Targeted professional development programs should be implemented to address variations in teachers' perceptions and teaching methods, ensuring consistency and improved instructional quality across classrooms.

Ongoing curriculum evaluation and refinement, guided by educator feedback and aligned with global educational standards, is crucial to maintaining curriculum relevance and effectiveness.

Finally, integrating digital tools into mathematics instruction is recommended to enhance student engagement, deepen conceptual understanding, and align teaching practices with evolving technological trends.

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