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RESEARCH ARTICLE

Alignment of Chemistry Textbooks for the Ninth and Tenth Grades in Jordan with Scientific and Engineering Practices (SEPs)

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ABSTRACT

This study aimed to investigate the extent to which chemistry textbooks for the ninth and tenth grades in Jordan align with scientific and engineering practices in light of the Next Generation Science Standards (NGSS). The study followed a descriptive-analytical approach and developed a content analysis tool based on the dimension of scientific and engineering practices according to the original NGSS document, and its psychometric properties were verified. The sample consisted of the chemistry textbooks for the ninth and tenth grades, in both parts (first and second). The results revealed that the inclusion of the dimension of scientific and engineering practices in the content of chemistry textbooks was low across all practices, except for the practice of "analyzing and interpreting data," which was moderately represented in both the ninth and tenth grades. The study recommended reconsidering the questions and scientific activities included in the chemistry textbooks for the ninth and tenth grades in Jordan to ensure a balanced and diversified inclusion of scientific and engineering practices.

INTRODUCTION

Science education has witnessed a series of reform movements in response to global changes. Among these are the Science-Technology-Society (STS) movement, the 2061 project by the American Association for the Advancement of Science (AAAS), and the National Science Education Standards (NSES) project (Bybee,2013). Recently, the National Research Council (NRC) in the United States, along with various organizations such as the National Academy of Science (NAS), the National Science Teachers Association (NSTA), and the organization ACHIEVE, developed the Next Generation Science Standards (NGSS), which were adopted in 2013 (NRC, 2013).

The NGSS includes three dimensions: cross-cutting concepts, disciplinary core ideas, and scientific and engineering practices (Malkawi & Rababah, 2018). These standards present a modern vision for science education, offering what is relevant for the 21st century and emphasizing the necessity of integrating all three dimensions in science teaching. These are: scientific and engineering practices (SEPs), disciplinary core ideas (DCIs), and cross-cutting concepts (CCCs), which students learn from kindergarten through to high school (KG-12) (Haverly et al., 2022). In light of the above, it is essential to continuously assess the content of curricula in general to determine how well they align with global reforms derived from specialized experiments and research. This is the primary objective of this study, specifically within the context of chemistry curricula.

Previous literature

The inclusion of scientific and engineering practices in science textbooks contributes to improving student learning. This enables students to understand how scientific knowledge develops, making their knowledge clearer, while engaging them in inquiry, modeling, and interpreting phenomena in the world. It helps them understand the work of engineers and the connections and relationships between engineering and science (Harris et al., 2015). Additionally, it fosters a deeper and broader understanding of overarching concepts and core ideas in science and engineering, sparking student curiosity and interest, motivating them to continue their studies, and providing them with insights that help them recognize that the work of scientists and engineers is a highly ethical endeavor with a significant impact on the world they live in (Merrit, Chiu, Burton & Bell, 2017).

In the same context, scientific and engineering practices represent what students are expected to do, rather than teaching methods or curricula. The Next Generation Science Standards (NGSS) intentionally avoid offering suggestions for teaching, as the goal is to describe what students should be able to do and identify the educational tasks through which these practices are carried out, rather than focusing on how they should be taught (Kang, Donovan & McCarthy, 2018). The eight practices are not isolated; they are intentionally interconnected. Scientific and engineering practices do not operate in isolation from one another but tend to unfold in sequence and overlap (Shapiro, 2018). For instance, asking questions may lead to modeling or planning and conducting an investigation, which in turn may lead to analyzing and interpreting data, and so on. It is essential for students to engage in all the practices and observe and deduce the relationships between them (Osborne, 2014). Performance expectations related to each practice are based on a portion of the abilities associated with that practice, not all of them. Each practice is linked to a set of skills across all grade levels, and it is natural that not all performances reflect all the abilities related to a practice. Therefore, the most appropriate abilities related to each grade level are identified (NGSS Lead States, 2013).

The next generation science standards (NGSS)

The Next Generation Science Standards (NGSS) document, according to the National Research Council (NRC, 2013), outlines these eight practices. These practices are not addressed separately but rather in an integrated and interconnected manner, which positively influences student learning as scientists and engineers. In the first practice, "Asking Questions and Defining Problems," the curriculum provides educational contexts that enable students to ask questions about the texts they read, the phenomena they observe, and the conclusions they draw from models or scientific investigations (Snider et al., 2014). In engineering, asking questions defines the problem that needs to be solved and generates ideas leading to specifications and characteristics for solving the problem in an organized way (Merritt et al., 2017).

In the second practice, "Using and Developing Models," students are able to create their own models in the early stages of their studies. These models start as tangible representations or miniature physical models, such as a car or a toy, and evolve into more abstract representations of related relationships in later stages (Concannon & Brown, 2017). In the third practice, "Planning and Carrying Out Investigations," students are able to plan different types of investigations and implement them according to their developmental stage. This requires active student participation in various types of inquiry (guided, semi-guided, and open-ended) (Watson et al., 2021). In the fourth practice, "Analyzing and Interpreting Data," students analyze and interpret data after it is collected. The data should be presented in a form that reveals patterns or relationships, as data alone has little meaning. The primary practice of scientists is to organize and interpret data through graphs or statistical analysis, which gives it value and meaning (Watson et al., 2021). Engineers also make decisions based on the validity of a particular design to function. They rarely rely on trial and error but instead analyze the design using a model or gather information to show how it works (Alkalaf, 2021).

Similarly, students engage in logical mathematical thinking in the fifth practice. Although there are differences in how mathematics and logical thinking are applied in the fields of science and engineering, mathematics often bridges the gap between these two fields (Kang et al., 2018). It enables engineers to apply mathematical models to scientific theories and allows scientists to use information technology designed by engineers (Moore et al., 2015). In the sixth practice, "Constructing Explanations and Designing Solutions," students recognize that science aims to build theories that explain phenomena in the world (Pruitt, 2014). A theory becomes accepted when it has several forms or methods of empirical evidence, allowing the theory to have a greater explanatory power for phenomena that distinguishes it from previous theories (Oliemat & Harafsheh, 2021).

Possessing scientific evidence allows students to engage in scientific argumentation in the seventh practice. This requires providing activities within the content of science textbooks that offer opportunities for scientific argumentation and explanation of phenomena, enabling students to present scientific arguments for their explanations supported by evidence and logic, and defend them using associated data to enhance the designs they propose (Trygstad et al., 2013). Finally, in the eighth practice, students must be able to obtain, evaluate, and communicate information. Science and engineering education requires developing students' abilities to research and investigate, identify relationships between different pieces of information, distinguish texts, and thus link all science or engineering lessons to language lessons, particularly reading, and produce new types of texts related to science and engineering (Hasanah, 2020).

Responding to these reforms requires the development of high-quality curricula. Curricula help educational systems address the challenges they face in shaping and developing individuals, and the creation of textbooks in alignment with global curriculum developments and reforms. The textbook is one of the most important educational resources for both students and teachers due to its significant educational value (Osborne, 2014). Reform movements in science education continuously provide insights into the quality of education and science learning, by offering textbooks that present scientific knowledge within its social, historical, and ethical context. These textbooks integrate with other branches of knowledge and contribute to the development of students' thinking skills (Tyler & DiRanna, 2018).

Previous studies

Researchers have focused on studying scientific and engineering practices across various branches of science. Some studies have shown unsatisfactory results regarding these practices. For example, the results of a study by Luqman (2023) indicated that the alignment of chemistry textbooks for the second secondary grade in Sudan with scientific and engineering practices was low. Similarly, the study by Oliemat & Harafsheh (2021) confirmed that the alignment of developed science textbooks for the fifth grade in Jordan with scientific and engineering practices (SEPs) was low, with some practices not being available. Al-Mashaqbah's study (2021) agreed with this finding, showing that the alignment of science textbooks for the eighth grade in Jordan with scientific and engineering practices in the field of life sciences was also low. In the same context, the results of Al-Masa'ed's study (2021) revealed that the alignment of science textbooks for the fourth grade in Jordan with scientific and engineering practices was low at 29.8%. This was confirmed by the results of Al-Tamimi's study (2021), which showed that the degree of availability of scientific and engineering practices in the science textbook for the third intermediate grade in Saudi Arabia was very low. Similarly, the results of Zayoud's study (2020) showed that the alignment of the science and life textbooks for grades three, four, and five of the Palestinian curriculum with scientific and engineering practices was low. The results of Al-Otaibi and Al-Jabr's study (2017) also pointed in the same direction, revealing that scientific and engineering practices in energy units in science textbooks for grades six, first, and second intermediate in Saudi Arabia were low.

On the other hand, studies with positive results showed more favorable findings. For example, the study by Breik (2021) found that the alignment of chemistry textbooks for grades 10 and 11 in Palestine with scientific and engineering practices was moderate. Similarly, the study by Ahl (2019) found that the alignment of science and life textbooks in Palestine with scientific and engineering practices for the sixth, seventh, and eighth grades was 68%, 62%, and 60%, respectively. The results of the study by Al-Buqami and Al-Jabr (2019) also pointed in the same direction, revealing that scientific and engineering practices appeared at a moderate level of 56.5%. Additionally, the study by Abu Hasel & Asmari (2018) confirmed that the presence of scientific and engineering practices in biology textbooks for the first and second secondary grades in Saudi Arabia was moderate. Similarly, the study by Abu Mousa (2022) found that the alignment of practical experiments in the content of science and life textbooks for the upper primary stage in Palestine with scientific and engineering practices was moderate. Moreover, in a study by Oliemat et al. (2021), the results showed that scientific and engineering practices in science textbooks for the fourth grade were highly present in the fields of physics and engineering design, and moderately present in the fields of earth and space science and life sciences.

Problem and questions of the study

The Next Generation Science Standards (NGSS) are among the most prominent standards that emerged in the 21st century, drawing the attention of those interested in teaching science to these standards and in developing science educational content that aligns with them (Rawaqa & Al-Momani, 2016). Several studies and conferences, both Arab and international, such as the 21st conference of the Egyptian Association for Curricula (2009), the second international scientific conference of the Egyptian Association for Curricula and Teaching Methods (2014), the first international conference on curricula in Sudan (2015), and the Educational Development Conference in Jordan (2015), have emphasized the need to develop science curricula and address their shortcomings, particularly in preparing learners for the 21st century, in line with global trends in science education, including the NGSS (Saleh, 2022).

In response to global reforms in science textbooks, the National Center for Curriculum Development in Jordan has continuously worked on developing curricula. Recently, the center developed the chemistry textbooks for the ninth and tenth grades. This study aims to analyze the developed chemistry textbooks for the ninth and tenth grades in Jordan in light of scientific and engineering practices, and to answer the following research questions:

- **First question**: What is the degree of alignment of the chemistry textbooks for the ninth and tenth grades in Jordan with scientific and engineering practices (SEPs)?
- **Second question**: Is there a difference in the degree of alignment of the chemistry textbooks in Jordan with scientific and engineering practices based on the grade level (ninth, tenth)?

Terms of the study

Scientific and engineering practices: "These are one of the dimensions of the NGSS, which emphasizes engaging students in scientific inquiry that requires specific knowledge for each practice, not just skills" (Castronova & Chernobilsky, 2020: p. 43).

Operationally, **scientific and engineering practices** are defined as the eight practices in the chemistry textbooks for the ninth and tenth grades, including: asking questions and defining problems, using models and developing them, building explanations and designing solutions, planning and carrying out scientific investigations, analyzing and interpreting data, using mathematics and computational thinking, engaging in argument from evidence, and obtaining, evaluating, and communicating information.

Boundaries of the study:

- **Subject boundaries**: Scientific and engineering practices in the content of the chemistry textbooks for the ninth and tenth grades in Jordan (2nd edition, 2023).
- **Time boundaries**: The first and second semesters of the 2023-2024 academic year.
- **Spatial boundaries**: The Hashemite Kingdom of Jordan.

Limitations of the study

The validity of the results and their generalizability depends on the degree to which the study tool adheres to its psychometric characteristics (validity and reliability).

METHODOLOGY AND PROCEDURES

First: Study approach

The study adopted a descriptive analytical approach for content analysis. The researcher analyzed the content of the chemistry textbooks for the ninth and tenth grades to determine the degree of inclusion of scientific and engineering practices.

Second: Study population and sample:

- **Study population**
  The study population consists of all the chemistry textbooks for the ninth and tenth grades, including both parts (first and second) for the 2023/2024 academic year, totaling 8 books. These include two student books, two activity and exercise books for the ninth grade, two

student books, two activity and exercise books for the tenth grade, and the teacher's guide for both grades.

- **Study sample**
  The sample of the study consists of the chemistry textbooks for the ninth and tenth grades, including both parts (student book and activity/exercise book), selected purposively to achieve the study's goal. The teacher's guide was excluded from the analysis.

Third: Study tool

To achieve the goal of the study, the researcher developed a content analysis card for the chemistry textbooks in light of the scientific and engineering practices dimension. This was done by reviewing the original standards for scientific and engineering practices in the NGSS document, as well as reviewing the literature and previous studies (Al-Otaibi & Al-Jabr, 2017; Oliemat et al., 2021; Al-Tamimi, 2021; Al-Mashaqbah, 2021).

- **Validity of the study tool**
  The validity of the content analysis tool for the scientific and engineering practices standards according to the Next Generation Science Standards (NGSS) was ensured by presenting its initial version, which was developed by translating the standards published on the official NGSS website. It was then reviewed by a group of specialists, including faculty members from Jordanian universities, educational supervisors, measurement and evaluation experts, and translators, to verify its validity in terms of: clarity of phrasing, accuracy of translation, relevance to the study, and appropriateness of the sub-indicators for the scientific and engineering practices dimension. Based on the feedback from the reviewers, the content analysis tool was revised to make it clearer, facilitating the content analysis process.
- **Reliability of the study tool**
  The reliability of the analysis tool was checked by assessing the consistency of analysis between the analysts. The researcher selected a sample from the content of the chemistry textbooks for the ninth and tenth grades and analyzed them. Another experienced analyst analyzed the same sample, and then the degree of agreement between the two analyses was calculated using the Holsti formula to measure the reliability coefficient:

$$\text{Reliability Coefficient} = \frac{2 \times \text{Number of agreed occurrences in both analyses}}{\text{Total number of occurrences in both analyses}} \times 100\%$$

Table 1: Reliability coefficient for the content analysis tool of chemistry textbooks for the ninth and tenth grades

Textbook	Unit	First Analyst	Second Analyst	Agreement Points	Reliability Coefficient
Tenth	First	124	119	116	95%
Ninth	Second	136	132	125	93%
Total		**260**	**251**	**241**	**94%**

Based on the previous equation, the reliability coefficient was 94%. Therefore, the analysis tool has a high degree of reliability and can be relied upon for content analysis of the chemistry textbooks for the 9^{th} and 10^{th} grades.

Study procedures:

1. Determine the indicators of the scientific and engineering practices dimension that should be present in the chemistry textbooks for the 9^{th} and 10^{th} grades.
2. Convert the required indicators in the chemistry textbooks for the 9th and 10th grades into a content analysis tool.
3. Verify the psychometric properties (validity and reliability) of the content analysis tool.
4. Define the purpose of the analysis: to determine the degree to which the indicators of the scientific and engineering practices dimension are present in the chemistry textbooks for the 9^{th} and 10^{th} grades.
5. Define the analysis category: The researcher used the scientific and engineering practices dimension as the main category for analysis, with its related indicators as sub-analysis categories.

6. Define the unit of analysis: The researcher relied on the unit of the idea as the unit of analysis, given its appropriateness to the nature and goals of the study.
7. Define the analysis sample: The sample included all topics covered in the chemistry textbooks for the 9th and 10th grades for the 2023-2024 academic year, comprising eight books: two student books and two activity and exercise books for the 9th grade, and two student books and two activity and exercise books for the 10th grade. The analysis covered: Check questions, lesson review questions, unit review questions, research questions, questions that simulate international test questions, activity analyses, and experiments included in the lessons. The teacher's guide and the repeated activities in the exercise book, which were already present in the student book, were excluded from the analysis.
8. Coding: Each sub-indicator was assigned a code.
9. Begin analyzing the chemistry textbooks in light of the scientific and engineering practices dimension and its sub-indicators presented in Table (3), by applying the coding.
10. The study adopted the following judgment criterion for the degree of inclusion used in the study by Oliemat et al. (2021):

Table 2: Judgment criterion for degree of inclusion:

Category	Degree of Inclusion
From 1% to less than 30%	Low Degree
From 30% to less than 65%	Medium Degree
From 65% to 100%	High Degree

11. Extract the results and present them in special tables.
12. Interpret and discuss the results.

Statistical treatment:

A number of statistical methods were used in this study to analyze the data collected, including frequencies, percentages, and the Holsti equation to calculate the reliability of the analysis.

STUDY RESULTS AND DISCUSSION

First: To answer the first research question, the frequencies and percentages of the scientific and engineering practices included in the chemistry textbooks for the 9th and 10th grades were extracted. See Tables (3) and (4).

Table 3: Frequencies and percentages of scientific and engineering practices included in the content of the 9th grade chemistry textbooks in Jordan.

Scientific and Engineering Practices	9th Grade		Degree of Inclusion
	Frequency	Percentage	
Asking Questions and Defining Problems	45	6.51%	Low
Using Models and Developing Them	56	8.10%	Low
Building Explanations and Designing Solutions	129	18.67%	Low
Planning and Conducting Scientific Investigations	88	12.74%	Low
Analyzing and Interpreting Data	251	36.32%	Medium
Using Mathematics and Computational Thinking	27	3.91%	Low
Engaging in Argument from Evidence	57	8.25%	Low
Obtaining, Evaluating, and Communicating Information	38	5.49%	Low
Total	**691**	**100%**	

Table (3) shows that the practice of Analyzing and Interpreting Data ranked first with a medium degree of inclusion (36.32%), followed by the practice of Building Explanations and Designing Solutions with a low degree of inclusion (18.67%). The practices of Planning and Conducting Scientific Investigations, and Engaging in Argument from Evidence ranked third and fourth, with percentages of 12.74% and 8.25%, respectively. The practice of (Using Models and Developing Them came in fifth place with a percentage of 8.10%, followed by Asking Questions and Defining Problems with 6.51%. The practices of Obtaining, Evaluating, and Communicating Information (5.49%), and

Using Mathematics and Computational Thinking (3.91%) ranked seventh and eighth, respectively. This variation could be attributed to the nature of the content in the 9th-grade chemistry textbooks and the level of inclusion of each standard.

The reason for the practice of "analyzing and interpreting data" (251 occurrences) ranking first, and "building explanations and designing solutions" (129 occurrences) ranking second, may be due to the focus of the learning outcomes in the 9th-grade chemistry curriculum, according to the National Center for Curriculum Development (2019), which concentrated on topics like exploring atoms, their components, and the stages of their discovery, as well as understanding the properties of acids, bases, and the chemical activity of certain metals.

The practice of "planning and conducting scientific investigations" ranked third with 88 occurrences. This result could be explained by the learning outcomes for the 9th-grade chemistry curriculum, which focused on inquiries like investigating the chemical activity of metals and exploring simple electrochemical cells and their applications.

The practices of "engaging in argument from evidence" with 57 occurrences, and "using models and developing them" with 56 occurrences, can be explained by the inclusion of activities in the 9th-grade chemistry textbooks that involve building models that simulate systems and phenomena, such as constructing atomic models and simple electrochemical cells.

The practices of "asking questions and defining problems" and "obtaining, evaluating, and communicating information" ranked sixth and seventh, with 45 and 38 occurrences, respectively. The low frequency of these practices may be due to their limited connection with the expected learning outcomes. It could also be due to the difficulty students face in mastering these skills in their integrated form (Al-Masa'id, 2021).

Finally, "using mathematics and computational thinking" ranked eighth and last with 27 occurrences. This result indicates that the 9th-grade chemistry textbook did not contribute much to using mathematical thinking and performing calculations. The researcher attributes this to the nature of the subject, as it was not emphasized during the preparation of the material and content of the textbooks.

Table 4: Frequencies and percentages of scientific and engineering practices included in the content of the 10th-grade chemistry textbooks in Jordan.

Scientific and Engineering Practices	**10th Grade**		**Degree of Inclusion**
	Frequency	**Percentage**	
Asking questions and defining problems	34	%5,50	Low
Using models and developing them	47	%7,61	Low
Building explanations and designing solutions	111	%17,96	Low
Planning and conducting scientific investigations	59	%9,55	Low
Analyzing data and interpreting it	192	%31,07	Medium
Using mathematics and computational thinking	110	%17,79	Low
Engaging in argument from evidence	22	%3,56	Low
Obtaining, evaluating, and communicating information	43	%6,96	Low
Total	**618**	**100%**	

Table (4) shows that "analyzing data and interpreting it" ranked first with a medium inclusion percentage (31.07%). The practice of "building explanations and designing solutions" followed with a low inclusion percentage (17.96%). The practices of "using mathematics and computational thinking" and "planning and conducting scientific investigations" ranked third and fourth with percentages of (17.79%) and (9.55%), respectively. The practice of "using models and developing them" ranked fifth with (7.61%), followed by "obtaining, evaluating, and communicating information" at (6.96%). "Asking questions and defining problems" and "engaging in argument from evidence" ranked seventh and eighth with percentages of (5.50%) and (3.56%), respectively. This variation can be attributed to the nature of the content in the 10th-grade chemistry textbook and the degree of inclusion of each standard.

The reason for the practice of "analyzing data and interpreting it" (192 occurrences) ranking first, and "building explanations and designing solutions" (111 occurrences) ranking second, may be attributed to the focus of the learning outcomes in the 10th-grade chemistry curriculum, according to the National Center for Curriculum Development (2019), which concentrated on exploring atoms and their development, identifying types of chemical bonds, and explaining the concept of the mole to perform chemical calculations.

"Using mathematics and computational thinking" ranked third with 110 occurrences, indicating that the 10th-grade chemistry textbook contributes to the use of mathematical thinking and performing calculations. This result can be explained by the inclusion of such topics in the preparation of the curriculum and content of the book.

"Planning and conducting scientific investigations" ranked fourth with 59 occurrences. This result may be explained by the fact that planning and conducting scientific investigations require skills and abilities that 10th-grade students might not fully possess, highlighting the need for curriculum developers to focus on how students acquire correct information.

"Using models and developing them" and "obtaining, evaluating, and communicating information" ranked fifth and sixth, with 47 and 43 occurrences, respectively. This can be explained by the inclusion of activities in the 10th-grade chemistry textbooks that involve building models to simulate systems and phenomena, such as constructing atomic models and using technology to explore energy associated with chemical reactions.

Finally, "asking questions and defining problems" and "engaging in argument from evidence" ranked seventh and eighth, with 34 and 22 occurrences, respectively. The low frequencies of these practices can be attributed to their limited connection with the expected learning outcomes in topics such as atomic structure, electron distribution, periodicity, chemical compounds and bonds, chemical reactions, and chemical calculations.

Results related to the second question:

To answer the second question, the researchers conducted a comparison between the chemistry textbooks for the ninth and tenth grades. See Table (5).

Table 5: The frequencies and percentages of results from analyzing chemistry textbooks for the ninth and tenth grades.

Scientific and Engineering Practices	**Grade**			
	Ninth Grade		**Tenth Grade**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Asking Questions and Defining Problems	45	6.51%	34	5.50%
Using and Developing Models	56	8.10%	47	7.61%
Constructing Explanations and Designing Solutions	129	18.67%	111	17.96%
Planning and Conducting Scientific Investigations	88	12.74%	59	9.55%
Analyzing and Interpreting Data	251	36.32%	192	31.07%
Using Mathematics and Computational Thinking	27	3.91%	110	17.79%
Engaging in Argument from Evidence	57	8.25%	22	3.56%
Obtaining, Evaluating, and Communicating Information	38	5.49%	43	6.96%
Total	**691**	**100%**	**618**	**100%**

Overall Total	**1309**	
Percentage for Each Grade	**52.8%**	**47.2%**

Table (5) shows that the scientific and engineering practices in both the ninth and tenth-grade chemistry textbooks were present at percentages of **52.8%** and **47.2%**, respectively. The inclusion of the scientific and engineering practices dimension in the content of the chemistry textbooks was generally low for all practices, except for the practice of analyzing and interpreting data, which was included at a medium degree in both the ninth and tenth grades. It is evident that there was a difference based on the grade level, as the ninth-grade chemistry textbooks contained more scientific and engineering practices than the tenth grade. Specifically, the ninth-grade practices occurred **691 times**, distributed across the following practices in order: Analyzing and Interpreting Data (251 times), Constructing Explanations and Designing Solutions (129), Planning and Conducting Scientific Investigations (88), Engaging in Argument from Evidence (57), Using and Developing Models (56), Asking Questions and Defining Problems (45), Obtaining, Evaluating, and Communicating Information (38), and Using Mathematics and Computational Thinking (27).

In comparison, the tenth-grade textbooks contained scientific and engineering practices **618 times**, distributed in the following order: Analyzing and Interpreting Data (192), Constructing Explanations and Designing Solutions (111), Using Mathematics and Computational Thinking (110), Planning and Conducting Scientific Investigations (59), Using and Developing Models (47), Obtaining, Evaluating, and Communicating Information (43), Asking Questions and Defining Problems (34), and Engaging in Argument from Evidence (22).

The results show that the ninth-grade chemistry textbooks contained a higher percentage of scientific and engineering practices compared to the tenth-grade textbooks, with the ninth grade accounting for **52.8%** and the tenth grade **47.2%**. This difference can be attributed to the nature of the activities prescribed in the textbooks for each grade level. The researcher explains the similar percentages between the ninth and tenth grades because the standards upon which both curricula were built were designed for a broader educational stage, not for just one specific grade. This was based on the scope and sequence matrix provided by the National Center for Curriculum Development (2019), which took into account the progression of ideas and skills.

The inclusion of the scientific and engineering practices dimension in the chemistry textbooks' content was low for all practices, except for Analyzing and Interpreting Data, which was included at a medium level in both the ninth and tenth grades. The researcher explains that the low frequency of scientific and engineering practices may be due to the National Center for Curriculum Development not relying solely on the NGSS standards when preparing the science standards in Jordan. Instead, they also considered modern trends for inclusion after analyzing and evaluating them, aiming to integrate global best practices while maintaining Jordan's national identity. These modern trends include standards from several Arab countries, including the United Arab Emirates and Kuwait, as well as global science curricula, US science teaching standards, the Project 2061 of scientific literacy, the Saskatchewan approach in Canada, and STEM (Science, Technology, Engineering, and Mathematics) practices, among others (National Center for Curriculum Development[NCCD], 2019). The medium inclusion of the practice of Analyzing and Interpreting Data with percentages of 36.32% for the ninth grade and 31.07% for the tenth grade is likely due to the nature of the content of these curricula, which focuses more on theoretical concepts rather than practical applications. This interpretation is supported by the lower inclusion of some scientific and engineering practices with practical components, such as Asking Questions and Defining Problems.

The results of this study align with those of Abu Hasil and Al-Asmary (2018), Al-Buqami and Al-Jabr (2019), and Al-Ahl (2019), regarding the inclusion of the scientific and engineering practices dimension in the content of the chemistry textbooks, which was at a low level for all practices except for Analyzing and Interpreting Data, which was included at a medium level in both the ninth and tenth grades. However, the findings differed from those of Al-Tamimi (2021), Al-Otaibi and Al-Jabr (2017), and Al-Masa'id (2021). Regarding the difference in the degree of inclusion of scientific and engineering practices in chemistry textbooks based on the grade level, the results of this study agree with most of the existing studies, including the study of Zyoud (2020).

CONCLUSION

Scientific and engineering practices provide a clear vision through important guiding principles. The theoretical literature and the results of previous studies have emphasized the importance of including scientific and engineering practices in the content of chemistry books, which positively reflects on students' learning. Students must be involved in all scientific and engineering practices at all educational levels (KG-12). Therefore, teachers and curriculum developers must follow strategies that contribute to the application of scientific and engineering practices. Scientific and engineering practices also develop and intersect more complexly as students progress through the grades. There is a certain way in which students grow, during which their abilities to use all scientific and engineering practices must develop through their integration and interaction in learning science. Each scientific and engineering practice reflects the nature of science or engineering. The eight practices can be used to contribute to the development and advancement of scientific research or to update and improve engineering design. Asking about the purpose of the activity is the best way to ensure that students practice science and engineering. If the answer to the question is knowledge, then students are dealing with science. If the purpose is to identify and solve the problem, then they are dealing with engineering.

From the results of the study, we conclude that the scientific and engineering practices dimension does not necessarily have all its indicators present in one grade in the same proportion, or in other grades. The availability rate of the scientific and engineering practices dimension in grades varies due to the nature of the activities prescribed in the books for each grade, and the nature of the scientific material in these grades. Curricula in that they focus more on analysis than on theory; This conclusion is supported by the high rate of availability of some scientific and engineering practices with an analytical aspect, such as the practice of (analyzing and interpreting data), the practice of (constructing explanations and designing solutions), Students are at an age that enables them to deal with abstract concepts. Scientific and engineering practices also appeared closely in chemistry textbooks for the ninth and tenth grades due to the close age group. Curriculum designers took these characteristics into consideration while preparing these curricula. This was reflected in the degree to which these practices were included in chemistry textbooks.

RECOMMENDATIONS:

1. Reevaluate the questions and scientific activities included in the chemistry textbooks for grades nine and ten in Jordan, ensuring a more balanced incorporation of scientific and engineering practices.
2. Focus on increasing the inclusion of Asking Questions and Defining Problems and Obtaining, Evaluating, and Communicating Information practices in the content of the chemistry textbooks for both grades, as these practices were not prominently featured compared to others.
3. Encourage curriculum developers to review and update the content of the chemistry textbooks for grades nine and ten in Jordan, aligning them with the scientific and engineering practices as outlined in the Next Generation Science Standards (NGSS).

SUGGESTIONS:

1. Conduct additional studies on chemistry textbooks at different educational stages to investigate the extent to which the Next Generation Science Standards (NGSS) are incorporated.
2. Conduct comparative studies between the chemistry textbooks for grades nine and ten in Jordan and those from other Arab countries, focusing on the inclusion of the scientific and engineering practices dimension, in order to assess the level of advancement in curriculum preparation and development in Jordan.
3. Conduct further research on the inclusion of other dimensions of the NGSS, specifically the Crosscutting Concepts and Disciplinary Core Ideas, in the chemistry textbooks for grades nine and ten in Jordan.

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