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RESEARCH ARTICLE

Alignment of Science Books with Scientific and Engineering Practices

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ABSTRACT

This study aimed to identify the scientific and engineering practices available in the physics field in the content of science books for the basic education stage in Jordan in light of the Next Generation Science Standards (NGSS). The study adopted the descriptive analytical approach, the study sample consisted of the physics field in the content of science books for the sixth, seventh, and eighth grades. The results of the study showed a low availability of certain scientific and engineering practices in the physics field in the content of science books across all grades, except for practice of Analyzing and interpreting information was medium degree with variations in the inclusion of scientific and engineering practices in the content of science books according to the academic grade, and in favor of the sixth grade. The study recommended employing inquiry-based activities in the physics field in science books in a deeper way, in line with scientific and engineering practices according to the (NGSS), taking into account the diversification of scientific and engineering practices in the physics field in science books across grades (6-8), and avoiding an overemphasis on any single practice to enhance and diversify the content.

INTRODUCTION

Reform movements in the field of science education are continuously providing insights into the quality of education. The focus is on learning science for understanding, constructivism, scientific culture, scientific inquiry and technological design, problem solving, critical thinking, creativity and the ability to make decisions from a personal and societal perspective, along with adapting to change in science (Bybee, 2013). This requires providing books that present scientific knowledge within its social, historical and ethical context, interactively with other branches of knowledge and contribute to developing students' thinking skills (Oliemat & Harafsha, 2021).

Supposedly, Global reforms are reflected in curricula. The school curriculum is the basis that encompasses various types of knowledge and skills needed by students, which require continuous updating of curricula, with their various skill, cognitive and emotional aspects; to provide students with the necessary knowledge and skills that enable them to keep pace with societal developments, and the ability to address contemporary problems (Smith & Nadelson, 2017). A well-planned curriculum works to expand students' cognitive horizons and increase their awareness of contemporary issues, which requires enhancing their skill level, such as analysis, interpretation, use of mathematical patterns, graphic representation, argumentation, and problem solving (Asunda, 2012).

Science education curricula in the United States of America emphasized the necessity of preparing students from the early grades of education to understand life sciences and perceive biological systems (Osborne, 2014). To achieve this, indicators of scientific culture and national standards in the field of life sciences have been developed, through the implementation of several successful educational projects in this field (Alkalaf, 2021). These projects have evolved from 1989 until they culminated in 2013 in the identification of the Next Generation Science Standards (NGSS), which presenting these standards in three dimensions: Scientific and Engineering Practices (SEPs), Disciplinary Core Ideas (DCIs) and Cross Cutting Concepts (CCCs); which students learn through the educational stages (KG-12) (Bybee, 2014).

The Next Generation Science Standards (NGSS) focus on ensuring that all students have sufficient knowledge and skills in scientific and engineering by the end of high school, through their specific framework that includes three dimensions: Disciplinary Core Ideas (DCIs), Cross Cutting Concepts (CCCs) and Scientific and Engineering Practices (SEPs) (Concannon & Brown, 2017). Specifically, scientific and engineering practices emphasize the practices of scientists in scientific research, and the practices of engineers in designing models and implementing solutions; in an attempt to provide students with the specific skills in scientific research and engineering design, enabling them to understand how scientists and engineers think (Merritt et al., 2018).

Based on the above, research specialists are interested in scientific and engineering practices. In the study of Abu Mousa (2022) which aimed to evaluate practical experiments in the content of science and life books for the upper elementary grades in Palestine in light of the dimension of scientific and engineering practices, the results confirmed that the moderate of availability of scientific and engineering practices. Meanwhile, in the study of Al-Ghamdi (2021), the results showed that the degree of availability of scientific and engineering practices in the content of the science book for the middle school was very low, in addition to the absence of engagement in scientific argumentation in these books. The results of Al-Tamimi's study (2021), which aimed to find out the degree of availability of the dimension of scientific and engineering practices in the science book for the ninth grade in the Kingdom of Saudi Arabia, aligned with the results of Al-Ghamdi's study (2021). The results of the study indicated that the degree of availability of the dimension of scientific and engineering practices in the science book for the ninth grade is very low.

In a related context (Oliemat and Harafsheh, 2021) conducted a study that aimed to show the degree of compatibility of the developed science books for the fifth grade with scientific and engineering practices (SEPs). The results indicated that scientific and engineering practices were available at a low level in the science book for the fifth grade, and some practices were not present at all. This is also what was reached by the study of Al-Otaibi and Al-Jaber (2017), which aimed to examine the extent of the scientific and engineering practices dimension in the energy unit in science books in the Kingdom of Saudi Arabia, as the results showed that the inclusion of all indicators of the scientific and engineering practices dimension in energy units across all grades (sixth primary grade, eighth grade, and ninth grade) was low. In light of the above, and in support of specialized research in scientific and engineering practices, and the continuous examination of science books to align them with global reforms in the field of science education, this is what this study sought to investigate.

Research Gap

The importance of examining the content of books lies in revealing the alignment of curricula with modern international standards, in terms of revealing strengths and weaknesses that require improvement, to develop them in line with these international standards and modern educational approaches (Watson et al., 2021). In particular, science curriculum reforms have undergone various transitional stages and milestones during their development, the most recent of which were the Next Generation Science Standards that appeared in 2013 (Bybee, 2013). In response to the ongoing reforms taking place in science education, and also in light of the results of the international TIMSS assessments, the National Center for Curriculum Development (NCCD) in Jordan is constantly reviewing and amending science books. Recently, the center developed science books for the primary stage (6-8) for the academic year 2022; to keep pace with the global reforms in science education, in addition to the low level of Jordanian students in the latest results of the international TIMSS assessments. Therefore, this study aimed to investigate the alignment of the physics field in the developed science books for grades (6-8) with scientific and engineering practices; addressing the research gap identified in the previous literature review.

Scientific and engineering practices

The process of integrating scientific and engineering practices into the content of science books contributes to improving student learning. Students are able to understand how scientific knowledge evolves, make their knowledge more explicit, and engage in investigation, modeling, and explanation of phenomena in the world. They understand the work of engineers and the links and relationships between engineering and science (Harris et al., 2015). In addition to fostering a deeper and broader understanding of the overarching concepts and basic ideas in science and engineering, it arouses students' curiosity and interests, motivates them to continue their studies, and possesses insights that help them know and realize that the work of scientists and engineers is an endeavor of high ethical value, which has a significant impact on the world in which they live. (Merrit, Chiu, Burton & Bell, 2018).

In the same vein, scientific and engineering practices represent what students are expected to do, rather than methods of teaching or specific curricula. The Next Generation Science Standards avoid making suggestions for teaching strategies, as the goal is to describe what students should be able to accomplish, and to outline the educational tasks through which the practices are performed, rather than focusing on how teaching should be conducted (Kang, Donovan & McCarthy, 2018). The eight practices are not separate but rather intentionally interconnected and overlapping. Scientific and engineering practices do not operate in isolation from each other but tend to unfold sequentially until they overlap. The practice of posing questions may lead to the practice of modeling or planning and conducting investigation, which in turn may lead to the analysis and interpretation of data. Thus, it is essential that students practice all practices, and monitor and observe and infer relationships between the eight practices (Osborne, 2014). Performance expectations associated with a practice are based on subset, but not all, of the abilities associated with that practice. Each practice is associated with a set of skills across all grades, and it is natural that not every performance reflects all the abilities associated with the practice. Therefore, the most appropriate abilities associated with each grade are identified. (NGSS Lead States, 2013)

The nature of scientific and engineering practices

The Next Generation Science Standards document outlined these eight standards according to the National Research Center (NRC, 2013). These practices are not addressed separately, but rather in an integrated and interconnected manner; which reflects well on students' learning as scientists and engineers. In the first practice of posing questions and identifying problems, the curriculum provides educational contexts that enable students to pose questions about the texts they read, the phenomena they observe, and the conclusions they reach from models or scientific investigations. In engineering, it is posing questions that define the problem to be solved, and obtaining ideas that lead to specifications and characteristics of the solution to the problem in an organized manner. (Summers & Abd-EL-Kalick, 2019).

In the second practice, using and developing models, students are able to create their own models in the early learning stages, which consist of tangible images, or small physical models such as a car or a toy, and develop to reach a more abstract level of related relationships in later stages. In the third practice, planning and conducting scientific investigation, students are able to plan and implement various types of investigation, in a manner that is appropriate for the age group. This requires active participation from students in different forms of inquiry, including (guided, semi-guided, and open-ended) investigations (Watson et al., 2021). While students can analyze and interpret information in the fourth practice, after collecting data, it must be presented in a form or format that can reveal patterns or relationships, as data alone has little meaning. The main practice of scientists is to organize and interpret data through graphs or statistical analysis, to give it value and meaning. Engineers also make decisions based on the viability of a particular design for work. They rarely rely on trial and error, but rather analyze the design through a model or collect information that shows how it works (Alkalaf, 2021).

In the same context, students practice logical mathematical thinking in the fifth practice. Although there are differences in how mathematics and mathematical thinking are applied in the fields of science and engineering, mathematics often links these two fields together, by enabling engineers to apply the mathematical model of scientific theories, and allowing scientists to use information technology designed by engineers. Students build explanations and invent solutions in the sixth practice. Students realize that science aims to build theories that explain phenomena in this world, and a theory becomes acceptable when it has several forms or methods of experimental evidence, which enables the theory to have greater explanatory power for phenomena that distinguishes it from previous theories (Shareb, 2019). Students' possession of scientific evidence enables them to engage in scientific argumentation in the seventh practice, and this requires providing activities within the content of science books that provide the opportunity for scientific argumentation, explaining phenomena, and enabling students to present scientific arguments for their explanations with evidence and proof, and to defend them with logic and related data to support the designs they propose. Finally, in the eighth practice, students must be able to obtain, evaluate, and communicate information. Teaching science and engineering requires developing students' abilities to research and investigate, distinguish relationships among different information, and distinguish texts. Hence, all science or engineering lessons are connected to language lessons, especially reading, and the production of new types of texts related to science and engineering. (Altamime, 2021)

METHODOLOGY

The study aimed to reveal the alignment of the physics field in science books for grades (6-8) in Jordan with the scientific and engineering practices emanating from the original Next Generation Science Standards document. To achieve the study objective, the study adopted the descriptive analytical approach based on describing and explaining what is present; with the aim of knowing the degree of alignment of the physical domain in science books for the basic education (grades 6-8) in Jordan with the dimension of scientific and engineering practices. The science books for the first and second semesters (student book, activities and exercises) for grades (6-8) were chosen intentionally to achieve the study objective. Specifically, the researcher analyzed the physics field in these books, which is represented in ten study units distributed as follows:

Four study units in each of the Student's Book and the Activities and Exercises Book for the Science subject for the sixth grade, first edition, in the academic year 2022/2023 A.D., with two units from the first semester, which are: the Matter Unit and the Work and Energy Unit, in addition to two units from the second semester, which are: the Sound Unit and the Heat Unit.

Three units in each of the Student's Book and the Activities and Exercises Book for the Science subject for the seventh grade, first edition in the academic year 2022/2023 A.D., with one unit from the first semester: the Force and Motion unit, in addition to two units from the second semester: the Light unit and the Electricity unit.

Three units in each of the Student's Book and the Activities and Exercises Book for the Science subject for the eighth grade, first edition in the academic year 2022/2023 A.D., with one unit from the first semester, which is: the Fluid Mechanics unit, in addition to two units from the second semester, which are: the Heat unit and the Magnetism unit.

Research Instrument

A content analysis card for science books was developed in light of the dimension of scientific and engineering practices, based on previous literature and previous studies, and scientific and engineering practices in the Next Generation Science Standards document (Alkalaf, 2021; Oliemat et al., 2021; Zioud, Khataiba, and Rababa'a, 2021; Al-Tamimi, 2021). Its validity was verified by presenting it to a several arbitrators from among the faculty members of Jordanian universities who specialize in measurement and evaluation, science curricula and teaching methods, language specialists, and science supervisors. Eight scientific and engineering practices were used, namely: posing questions and identifying problems, using and developing models, planning and conducting scientific investigation, analyzing and interpreting information, practicing logical mathematical thinking, constructing explanations and inventing solutions, engaging in argumentation, and obtaining, evaluating, and communicating information.

The reliability of the analysis instrument was calculated through the reliability of the analysis for the analysts, as two units were selected from the sixth grade book, part one, which are: the unit of matter, and the unit of work and energy, and the researcher analyzed them. After that, the researcher explained the analysis mechanism to his colleague, and asked him to analyze the same two units individually. After obtaining the results, the agreement coefficient between the analysts was calculated using Holsti's stability coefficient: $CR= 2M/(N1+N2)$. The reliability coefficient reached (83%), which is a high coefficient indicating the reliability of the analysis card instrument, as the reliability coefficient must not be less than (60%) in order to be approved based on the study of Oliemat & Harafsha, (2021); therefore, the current analysis card can be relied upon in analyzing the physics field in science books (grades 6-8).

Analysis Procedures

The researchers carried out a number of procedures during the analysis of the content of the scientific material, which are:

- Determining the objective of the analysis: Knowing the degree of availability of indicators of the dimension of scientific and engineering practices in the physics field of science books for the basic grades (6-8).
- Determining the unit of analysis: The unit of analysis was the idea contained in the paragraphs, figures, pictures, activities, exercises, experiments, questions included, and questions at the end of the lesson and unit.
- Defining the analysis categories: The researcher used the dimension of scientific and engineering practices as a main category for analysis, and its indicators as sub-categories of analysis.
- Coding: A code was assigned to each of the sub-indicators.
- Determining the controls of the analysis process: The researcher identified a number of controls, which are:
- The analysis process included the physics field in the science books for the basic stage for grades (sixth, seventh, eighth) in their first and second parts, which are the first edition of the student book and the book of activities and exercises for the aforementioned grades scheduled for the academic year 2022/2023.

The analysis process did not include the teacher's guide.

- The analysis process included analyzing activities, I check questions, I research questions, lesson review questions, experiments included in lessons, scientific investigation, unit review questions, and questions that simulate international test questions.
- Duplicate activities in the workbooks and student's book and their questions were excluded during the analysis process.

STUDY RESULTS AND DISCUSSION

The study adopted the standard of judging the degree of alignment of scientific and engineering practices in science books (6-8 grades) to answer its questions, by using the three-point scale used in the study of Oliemat and others (2021), and the study of Al-Otaibi and Al-Jaber (2017): low degree (1% - >30%), medium degree (%30 - > 65%), and high degree (%65 – 100%).

Question 1: What is the degree of alignment of the physics field in the content of sixth grade science books in Jordan with scientific and engineering practices?

To answer the question, the frequencies and percentages of scientific and engineering practices in the content of science books for the sixth grade in Jordan were extracted. See Table (1).

Table (1): Frequencies and percentages of scientific and engineering practices in sixth grade science books.

Scientific and Engineering Practices	Frequency	Percentage%	Degree
Posing questions and identifying problems	8	3.4%	Low
Using and developing models	32	13.5%	Low
Planning and scientific investigation	18	7.6%	Low
Analyzing and interpreting information	98	41.5%	Medium
Practicing logical mathematical thinking	14	6%	Low
Building explanations and inventing solutions	34	14.4%	Low
Engaging in argumentation	6	2.6%	Low
Obtaining, evaluating and communicating information	26	11%	Low
Grand Total	236	100%	

Table (1) shows that scientific and engineering practices were repeated in the physics field in the science books for the sixth grade (236) times, and in first place was the practice of (analyzing and interpreting information) (98 repetitions), at a rate of (41.5%) with a medium degree, while in last place came the practice of (engaging in argumentation) with a repetition of (6 repetitions), at a rate of (2.6%) with a low degree.

The inclusion of scientific and engineering practices in the physics field in the sixth-grade science book was uneven. Such variation may be attributed to the nature of the content of the book for the sixth grade, the level of inclusion of scientific and engineering practices, and the extent to which these practices are related to the topics of the specialized ideas dimension, as indicated by Omar (2020). The practice of (analyzing and interpreting information) obtained (98) repetitions in the first place, and the practice of (building explanations and inventing solutions) obtained (34) repetitions in the second place, can be explained by the fact that the learning outcomes in the physics field for the sixth grade are related to exploring and distinguishing between materials, identifying their properties, and identifying the general principles available in the physics field in the science books for the sixth grade (NCCD, 2019).

Although the learning outcomes focused on the scientific investigation of some phenomena included in the physics field of the sixth grade science books, such as: investigating the forms of mechanical energy, and investigating heat transfer, the practice of (scientific planning and investigation) came in fifth place with (18) repetitions, a percentage of (7.6%), in a way that may not achieve the desired learning outcomes. This may be attributed to the fact that scientific investigation in its true and complete form requires effort, skills, and capabilities from students that sixth grade students may not possess, and this is what was confirmed by the study of Al-Tamimi (2021). Therefore, it is possible to say that the curriculum developers' interest in the way in which the student obtains correct and reliable information to explain the scientific phenomenon in support of scientific investigation is an attempt by the curriculum developers to achieve these outcomes; which clearly supported the existence of the practice of (obtaining, evaluating and communicating information), which ranked fourth through (26) repetitions, at a rate of (11%).

The third place was occupied by the practice of (using and developing models) with (32) repetitions, at a rate of (13.5%). This percentage may explain the fact that the physics field in science books contains some activities that are based on building models that simulate some physical systems and phenomena and using them, such as: building a model of the path of a body with the aim of determining the factors affecting kinetic energy and potential energy, building a model of gears, and building models of atoms. Meanwhile, the practice of logical mathematical thinking came in sixth place with a number of repetitions of (14) repetitions, at a rate of (6%), the practice of (posing questions and identifying problems) and the practice of (engaging in argumentation) came in seventh and eighth place respectively with a repetition of (8) and (6) for each, at a rate of (3.4%) and (2.6%) respectively. The low percentages of these practices may be explained by their lack of connection to the expected outcomes in the fields of mechanics and waves, heat transfer, and material, its composition and properties. Based on the study of Oliemat & Harafsheh (2021) it is likely that the result is attributed to the difficulty of students possessing these skills in their integrated form because they are not appropriate for the age period and developmental characteristics of this age.

Question 2: What is the degree of inclusion of scientific and engineering practices in the physics field in the content of science books for the seventh grade in Jordan?

To answer the question, the frequencies and percentages of scientific and engineering practices in the content of science books for the sixth grade in Jordan were extracted, see Table (2).

Table (2): Frequencies and percentages of scientific and engineering practices in seventh grade science books.

Scientific and Engineering Practices	Frequency	Percentage%	Degree
Posing questions and identifying problems	4	1.9%	Low
Using and developing models	17	8%	Low
Planning and scientific investigation	15	7%	Low
Analyzing and interpreting information	85	40%	Medium
Practicing logical mathematical thinking	41	19.1%	Low
Building explanations and inventing solutions	42	20%	Low
Engaging in argumentation	0	0%	Low
Obtaining, evaluating and communicating information	9	4%	Low
Grand Total	213	100%	

Table (2) shows that scientific and engineering practices were repeated in the physics field in the science books for the seventh grade (213) times, and in first place was the practice of (analyzing and interpreting information) (85 repetitions), at a rate of (40%) with a medium degree, while in last place came the practice of (engaging in argumentation) due to the lack of any repetitions related to its indicators.

The results of the analysis of the seventh-grade science books show a difference in scientific and engineering practices, with the practice of (analyzing and interpreting information) being the most frequent, followed by the practice of (building explanations and inventing solutions). This result may explain that the learning outcomes of the physical sciences field for the seventh grade focus on understanding, clarifying, or identifying concepts related to the axes of the physical sciences field such as mechanics, force and motion, waves, electricity, and magnetism (NCCD, 2019). To achieve such outcomes, the student is likely to analyze information and use valid and reliable evidence to build explanations for physical phenomena and invent solutions to problems (Wtson et al., 2021). While the practice (practicing logical mathematical thinking) came in third place with (41) repetitions, at the rate of (19.1%). This may be attributed to the existence of learning outcomes that require the use of numbers and logical mathematical comparisons to achieve them, and due to the curriculum containing numerous graphs to illustrate various relationships such as the effect of force on the movement of the body, and to describe the movement of bodies, and various comparisons.

The practice of (using and developing models) came in fourth place (17) repetitions, at a rate of (8%), and the practice of (planning and scientific investigation) came in fifth place (15) repetitions, at a rate of (7%). These low percentages can be attributed to the lack of learning outcomes achieved through scientific investigation and model building (NCCD, 2019). The practice of (obtaining, evaluating and communicating information) came in sixth place (9 repetitions), at a rate of (4%). The practice of (posing questions and identifying problems) came in seventh place with a number of repetitions of (4 repetitions), at a rate of (1.9%). According to the White's study (2014), the low percentages of these practices may be attributed to their need for the learner to have higher skills and levels of thinking that may be difficult for the student at this stage to be able to apply and practice in an ideal manner. While the practice of (engaging in argumentation) and its indicators were absent, this may be due to the absence of any learning outcomes related to argumentation, which was reflected in the curriculum, as it did not include any of the indicators related to this practice, according to the National Center for Curriculum Development (NCCD, 2019).

Question 3: What is the degree of inclusion of scientific and engineering practices in the physics field in the content of science books for the eighth grade in Jordan?

To answer the question, the frequencies and percentages of scientific and engineering practices in the content of science books for the sixth grade in Jordan were extracted, see Table (3).

Table (3): Frequencies and percentages of scientific and engineering practices in eighth grade science books.

Scientific and Engineering Practices	Frequency	Percentage%	Degree
Posing questions and identifying problems	5	2.3%	Low
Using and developing models	18	8.4%	Low
Planning and scientific investigation	16	7.5%	Low
Analyzing and interpreting information	83	38.8%	Medium
Practicing logical mathematical thinking	32	15%	Low
Building explanations and inventing solutions	46	21.5%	Low
Engaging in argumentation	0	0%	Low
Obtaining, evaluating and communicating information	14	6.5%	Low

Grand Total	214	100%	

Table (3) shows that scientific and engineering practices were repeated in the physics field in the science books for the eighth grade (214) times, and the most frequent practice was (analyzing and interpreting information) (83) repetitions, at a rate of (38.8%), followed by (building explanations and inventing solutions) in second place (46) repetitions, at a rate of (21.5%), followed by (practicing logical mathematical thinking) came in third place (32) repetitions, at a rate of (15%), followed by (using and developing models) came in fourth place (18) repetitions, at a rate of (8.4%), followed by (planning and scientific investigation) in fifth place (12) repetitions, at a rate of (7.5%), followed by (obtaining, evaluating and communicating information) in sixth place (14) repetitions, at a rate of (6.5%), followed by (posing questions and identifying problems) in seventh place (5) repetitions, at a rate of (2.3%), and followed by the practice (engaging in argumentation) came in last place due to the lack of any repetitions related to its indicators.

The results of the analysis of the eighth grade science books showed a difference in scientific and engineering practices. The most frequent practice was (analyzing and interpreting information) (83) repetitions, at a rate of (38.8%), and the practice of (building explanations and inventing solutions) came in second place with (46) repetitions, at a rate of (21.5%). These percentages may be attributed to the nature of the learning outcomes, as the learning outcomes focused clearly on clarifying and understanding concepts, such as clarifying concepts related to fluid mechanics, and clarifying concepts related to thermal processes. The practice of (practicing logical mathematical thinking) came in third place (32) repetitions, at a rate of (15%). This result may be attributed to the fact that the nature of the scientific material is based on the use of numbers and mathematical equations and dealing with them, especially in the fluid mechanics unit and the heat unit. The practice of (using and developing models) came in fourth place (18) repetitions, at a rate of (8.4%). This percentage may explain the presence of some diverse activities in the physics field in the eighth grade science book that were based on the use and construction of models, such as explore activities and various experiments.

The practice (planning and scientific investigation) came in fifth place (12) repetitions, at a rate of (7.5%). This percentage can be explained by the fact that the physics field in the science book for the eighth grade contains scientific investigation activities in a low way, and the use of observing natural phenomena to monitor them, and asking questions to clarify them. The practice (obtaining, evaluating and communicating information) came in sixth place (14) repetitions, at a rate of (6.5%). The reason for this result may be the lack of interest in this practice during the preparation of the science curriculum for the eighth grade; because the National Center for Curriculum Development did not give this practice the attention of the (NCCD, 2019). The practice (posing questions and identifying problems) came in seventh place with a number of repetitions of (5) repetitions, at a rate of (2.3%). This low result may be attributed to the inclusion of the practice of posing questions in scientific investigation as one of the ways to observe natural phenomena, science can begin by asking about the physical phenomenon to reach its explanation (Al-Mashaqbeh, 2021). The practice of (engaging in argumentation) came in last place with a percentage of (0%). This can be explained as a result of the lack of learning outcomes related to this practice (NCCD, 2019). Argumentation is a complex process that requires the presence of an educational environment prepared in a way that contributes to the student's engagement in this practice (Hasanah, 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 science 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 student's 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 dimension of scientific and engineering practices does not necessarily have all its indicators available in the same class, or in other classes. The difference in the availability rate of the dimension of scientific and engineering practices in classes is due to the nature of the activities prescribed in the books for each class, and the nature of the scientific material in these curricula in terms of its focus on theoretical concepts more than the applied aspect. This conclusion is supported by the low availability rate of some scientific and engineering practices with an applied aspect, such as the practice of (posing questions and identifying problems), and the practice of (engaging in argumentation), and the variation in cognitive and skill abilities due to the difference in age group. Sixth grade students tend to learn concretely, while seventh and eighth grade students are at an age that enables them to deal with abstract concepts. Curriculum designers took these characteristics into consideration while preparing these curricula, which was reflected in the degree of inclusion of these practices in various science books.

RECOMMENDATIONS

In light of the study results, the following is recommended:

- Employing investigative activities in the physics field in science books (6-8 grades) in a deeper way, in line with scientific and engineering practices according to the Next Generation Science Standards (NGSS).
- Taking into account the diversity of scientific and engineering practices in the physics field in science books (6-8 grades), and not focusing on one practice over another; for the sake of enrichment and diversity.
- Taking into account increasing the space allocated to employing scientific and engineering practices in science books for grades (6-8 grades), specifically in the physics field.

AUTHORS' CONTRIBUTIONS

Author AO contributed to applying the study tools, extracting the results and interpreting them. Author MA contributed to providing advice to author AO at all stages of completing the study, and he is also credited with proofreading of the article and documenting the references.

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