

Mapping the representation of four SDGs in international elementary science curriculum and textbooks

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Abstract

Education for sustainable development (ESD) equips individuals with perspectives of value, ethics, foresight, and long-term decision-making regarding our future. Education plays a crucial role in acquiring the necessary knowledge and behaviors related to sustainable development (SD). Additionally, the curriculum can facilitate students in gaining competencies related to the sustainable development goals (SDGs). This study aims to explore how SDGs 4, 6, 8, and 15 and their three relevant competencies (knowledge and understanding; skills and applications; and values and attitudes) are incorporated in the current United Arab Emirates (UAE) elementary school science curriculum framework (2022) and science textbooks (grades 1-4). Guided by a qualitative approach, this study utilized content analysis for examining the objectives of the science curriculum and document analysis for assessing the extent to which SDGs are addressed in science textbooks. The results indicated that the science curriculum framework prominently features skills and applications for SDG 4 across all four grades. There was a moderate representation of knowledge and understanding and skills and applications for SDG 15, while SDG 6 and SDG 8 were represented minimally or not at all at times. Furthermore, the analysis revealed that no grade completely represented all three dimensions for any of the SDGs. Instead, the social dimension of SD was represented in SDG 4, the economic dimension in SDG 8, and the environmental dimension primarily in SDG 15 and occasionally in SDG 6. The document analysis of the Science textbooks from grades 1-4 showed similar findings to the content analysis. Overall, SDG 4–Quality education was the most represented goal in both the science curriculum framework and science textbooks, followed by SDG 15–Life on land, with SDG 6–Clean water and sanitation and SDG 8–Decent work and economic growth having the least representation. For SD to be achieved, curricula must be enhanced, updated regularly, and revised constantly. Learning outcomes should align closely with SDGs to ensure appropriate representation at each grade level.

Keywords: sustainable development goals, science curriculum, education for sustainable development, content analysis, elementary education, UAE education policy

INTRODUCTION

The sustainable development goals (SDGs) represent a pivotal multilateral agreement on global development through 2030, a framework particularly significant for the United Arab Emirates (UAE) both as a nation and as a prominent international donor (Labuschagne, 2003). These goals introduce a comprehensive approach to

development, emphasizing growth strategies that ensure economic, environmental, and social sustainability for future generations (UAE National Committee on Sustainable Development Goals, 2017).

The UAE views the prioritization of a high-quality life for future generations as essential for national success and for maximizing the impact of its foreign aid

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Contribution to the literature

- This study contributes to the existing literature by examining the integration of Sustainable Development Goals (SDGs) 4, 6, 8, and 15 within the UAE elementary science curriculum framework (2022) and science textbooks for grades 1–4.
- The study provides a detailed analysis of how the three competencies – knowledge and understanding, skills and applications, and values and attitudes – are addressed in the curriculum.
- The findings highlight the prominence of SDG 4 (Quality Education) across all grades, moderate representation of SDG 15 (Life on Land), and minimal inclusion of SDG 6 (Clean Water and Sanitation) and SDG 8 (Decent Work and Economic Growth).
- By identifying gaps in the curriculum and the uneven representation of SDGs across social, economic, and environmental dimensions, this study underscores the need for curricula to be regularly updated and closely aligned with SDGs to promote education for sustainable development (ESD).

contributions. The country has played a crucial role in the SDG discourse, notably supporting the goals as a key outcome of the Rio+20 Summit and facilitating their institutionalization leading up to their adoption by the United Nations (UN) in 2015. Moreover, the UAE is redefining the global perception of the Middle East and North Africa region by advancing women’s empowerment, sustainable energy, climate action, and leading initiatives in education, poverty eradication, and health.

The SDGs are integral to the UAE’s legacy and its strategic vision for the future, aligning with the nation’s comprehensive development plans. The UAE’s National Committee on SDGs is dedicated to synchronizing the efforts of all ministries to fulfill the SDGs within their existing development frameworks, including Vision 2021 and the UAE Centennial 2071 strategy.

In 2016, the Cabinet expanded its focus to include happiness, tolerance, future, and youth, continuously adapting its approach to sustainable development (SD) by appointing ministers for food security, advanced sciences, and artificial intelligence. This commitment to youth engagement ensures that the upcoming generation is actively incorporating the SDGs and their principles into the country’s developmental blueprint.

The SDGs and Education

The 17 SDGs encompass a broad range of global challenges, including poverty, hunger, inadequate water supply, urban sustainability, peace, health, education, energy, employment, and industrial growth. Central to achieving these goals is education, which the UN explicitly highlights as a pivotal force for SD. The United Nations (2015) articulates this mission in a direct quote:

By 2030, ensure that all learners acquire the knowledge and skills needed to promote SD, including, among others, through education for sustainable development (ESD) and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and culture’s contribution to SD (United Nations, 2015).

This statement underscores the multifaceted role of education in fostering a sustainable future, emphasizing not just the acquisition of knowledge and skills but also the cultivation of values and attitudes conducive to SD. SD targets present a vision for transformative change, where education acts as a pivotal enabler for achieving these goals. The essential acquisition of skills and knowledge forms the cornerstone for realizing SD and its broad objectives. Moreover, effective decision-making and active participation in SD-related issues necessitate individuals who are not only informed but also capable of instigating positive change. Education thus plays a critical role in equipping individuals with the necessary knowledge, skills, values, and attitudes for a sustainable future. Specifically, ESD is designed to empower students to critically reflect on their behaviors and assess their impact on social, environmental, and economic dimensions, thereby embodying the comprehensive approach envisioned for SD (Rieckmann, 2017).

The development of student competencies such as knowledge, skills, values, and attitudes can be facilitated through well-designed textbooks and curricula that serve as educational guides. To this end, the “curriculum framework for the SDGs” was developed to highlight education’s role in achieving SD and the SDGs, providing a roadmap for countries to update their curricula accordingly (Osman et al., 2017).

Textbooks play a crucial role in conveying SDGs, encapsulating societal values, policies, historical understanding, and pedagogical practices. Recognized for their informative and authoritative content, textbooks significantly influence teaching and learning processes (UNESCO, 2016). They not only present knowledge but also reflect community values and priorities, thereby supporting the development of high-quality curricula (Jimenez et al., 2017). Covering a wide range of topics from cultural norms to environmental and technological issues, textbooks are integral to embedding real-life issues into education, aligning with SDGs.

Science education is instrumental in raising student awareness about SD concepts, spanning diverse disciplines like biology, chemistry, physics, astronomy, and geology. This interdisciplinary approach addresses global challenges from biodiversity loss to disaster risk reduction, underscoring the importance of integrating competencies and concepts related to SD into science curricula.

The alignment of educational curricula, particularly science curricula, with the SDGs remains underexplored in the UAE. This study fills a research gap by examining the integration of SDGs and associated competencies within the UAE elementary school science curriculum and textbooks. Investigating how knowledge, competencies, and skills related to SD are incorporated forms the core of this study. As the concept of a sustainable future gains traction, the emphasis on education as the pathway to achieving such a future increase, highlighting the role of students equipped with essential knowledge, understanding, and pedagogical strategies.

Study Purpose and Objectives

The purpose of this study was to explore how the four specified SDGs and their associated competencies (knowledge and understanding; skills and applications; values and attitudes) are integrated into the current UAE elementary school science curriculum (2022) and science textbooks for grades 1 to 4 (Ministry of Education, 2024). A content analysis methodology was applied to assess the objectives of the science curriculum, while a document analysis technique was utilized to evaluate the science textbooks, focusing on the incorporation of SDGs-related objectives.

Study Questions

1. Which objectives in the UAE elementary school science curriculum (2022) for grades 1-4 are aligned with the four SDGs (4, 6, 8, and 15)?
2. What clusters of learning competencies (knowledge and understanding; skills and applications; values and attitudes) are identified for the four SDGs in the science curriculum for grades 1-4?
3. What are the learning outcomes associated with the SDGs' learning competencies in the science curriculum for grades 1-4?
4. How are the four SDGs distributed in relation to objectives across the three dimensions of ESD (economic, social, and environmental)?

The content of textbooks reflects community values and priorities, significantly contributing to the development of high-quality educational curricula. Analyzing textbooks is crucial for understanding how educational materials tackle vital issues, including those

pertaining to SDGs, thus enabling comprehensive and informed learning. This study reveals the extent of alignment between the four SDGs and the science curriculum for grades 1-4, identifying the levels of emphasis placed on each SDG from most to least prominent. Given its interdisciplinary nature, science education encompasses a broad array of subjects, from global issues to everyday challenges. Consequently, embedding competencies and concepts related to SDGs in science curricula is essential for enhancing student awareness about the linkages between scientific knowledge and real-world issues.

LITERATURE REVIEW

Competence and curriculum are two interconnected principles that significantly influence education for sustainable growth. The curriculum serves as a framework within which knowledge is developed around essential characteristics such as skills, beliefs, behaviors, and attitudes, collectively shaping an individual in all aspects. While numerous international studies have explored SD within the curriculum or textbooks, others have recognized SD in the curriculum through environmental education and action or task-based learning. Additionally, there is research focusing on the examination of higher education curricula regarding SD. Jóhannesson and his colleagues explored how the Icelandic public-school curriculum for early childhood, compulsory, and upper secondary school addresses education for SD (Jóhannesson et al., 2011). Their study revealed that the Icelandic curriculum emphasizes values, opinions, and emotions concerning nature and the environment. It expects children and teenagers to learn responsibility towards nature and the environment and to foster an ethical sense, which is crucial for ESD and aligns with the UN SDGs. The curriculum also highlights the importance of knowledge in promoting sensible use of nature, scientific literacy, and discussions on the viability of specific actions, supporting democracy, participation, and action competence, with an emphasis on healthy lifestyles, attitudes to life, and democratic skills (Jóhannesson et al., 2011). Critical thinking, tolerance, and active participation in democratic processes are further emphasized, with students expected to become proficient in ethical deliberations and enhance their social skills, citizenship identity, and respect for themselves and others. Issues of equality, including multiculturalism, are woven throughout the curriculum, teaching children and young people about inequality and the prohibition of discrimination, with an expectation of respect for all, regardless of origin, life views, language, or religion (Jóhannesson et al., 2011).

At upper school levels, there is a greater focus on understanding racism and other forms of discrimination. The curriculum also notes the importance of immigrants maintaining connections to aspects of their original

culture, such as language or religion. Although the Icelandic curriculum offers opportunities to promote sustainability and SD among children and teenagers at all school levels, it was observed that there is a lack of focus on economic development and prospects. The inclusion of consumer education in compulsory and upper secondary schools encourages critical scrutiny of current needs and their development towards sustainability. The study recommended strengthening the curriculum in this area to better align with the UN' decade goals (Jóhannesson et al., 2011).

Another study investigated the extent to which technology-related disciplines in Irish post-primary schools integrate and address ESD concerns (McGarr, 2010). This study sought a balanced perspective by examining existing and planned new syllabi, teaching guides, department of education and science publications, assessment materials, chief examiner reports, and known publications related to technology education in Ireland.

The revision of technology curricula in the Irish post-primary system at that time offered an opportunity to address concerns that contemporary education may contribute more to the challenges of SD rather than its resolution, prompting a reorientation of syllabi. An advocacy for the integration of ESD to extend beyond merely raising awareness, especially concerning environmental issues was made. The study highlighted the challenge of introducing a critical dimension that questions the beliefs and perceptions of both teachers and students regarding technology. Proposed strategies included auditing existing and proposed syllabi to identify areas lacking in sustainability, analyzing student activities, and ensuring that technology subjects are engaging, realistic, and address significant problems. Furthermore, it emphasized the importance of reevaluating the traditional focus and justification of subjects to maintain their relevance and effectiveness in technological education (McGarr, 2010).

A qualitative case study examined the middle school science curriculum and science textbooks from 5th to 8th grades, utilizing content and document analysis to assess the objectives (Tatlıoğlu, 2019). The findings indicated a predominance of knowledge and understanding competence in the 8th grade, while values and attitudes competence was more emphasized in the 7th and 8th grades. The environmental dimension received greater focus in SDGs-related objectives.

The consistency of the approach to science education in relation to the SDGs within the Turkish science curriculum was determined through a study conducted by two researchers (Yüzbaşıoğlu & Kurnaz, 2022). Employing a document review method, the 2018 curriculum learning outcomes were analyzed, revealing that SDGs were linked to 58 of the 302 learning outcomes. The study found that the scientific course

curriculum does not fully meet the SDGs, with only 20% of learning outcomes related to sustainability, highlighting a gap in sustainability education. The study stressed the importance of prioritizing SD education and aligning learning outcomes with environmental objectives, given the critical nature of teaching environmental issues to future generations. Recommendations included ensuring that SDG-related learning outcomes are age-appropriate and more extensively integrated into the earth and universe subject areas (Yüzbaşıoğlu & Kurnaz, 2022).

Boehn and Hamann (2011) investigated the representation of the ESD concept in geography textbooks across 1st to 11th grades in Bavaria, employing quantitative and qualitative analyses, including a meta-level review. This involved manual and keyword searches in glossaries to identify terms related to sustainability and SD. The analysis determined that concepts of sustainability and SD were infrequently found in textbooks. While "sustainability" was introduced as a concept and implicitly incorporated into various themes, "SD" was described as a process, and "sustainable" was used as an adjective modifying other concepts. The study concluded that environmental aspects predominated in illustrated topics over social and economic ones.

Haque conducted a study to examine the inclusion of ESD within the national curriculum of Bangladesh at the primary education level (Haque, 2013). Utilizing secondary data analysis and content analysis, this exploratory investigation reviewed the newly updated 2013 curriculum and textbooks from first to fifth grades, highlighting that the study extended beyond a single educational subject area, such as science. The findings indicated that a comprehensive range of ESD-related issues were incorporated across all specified levels within the textbooks. Additionally, the study identified challenges that are crucial for long-term development, suggesting that the revised curriculum presents an opportunity to integrate essential topics like environmental, health, personal, or social education.

Sætre explored the implementation of the ESD concept within Norwegian geography courses through qualitative content analysis (Sætre, 2016). The results were categorized into two main sections: the status of environmental education and ESD in the geography curriculum before and after the introduction of Agenda 21 in primary, lower, and upper secondary schools. The analysis showed minimal changes in the curricula following the adoption of the ESD concept and no significant differences between upper secondary and compulsory education levels. Geographical issues were found to be closely linked to the environmental dimension of SD, with a focus on the interaction between humans and nature. Despite the curriculum's mention of the concept, there was a noted lack of implementation and detailed explanation regarding ESD. The study

concluded that the inadequate implementation of ESD in Norway might stem from its low prioritization within Norwegian schools and the absence of a strategic action plan for ESD integration. Furthermore, the study observed that ESD was often relegated to an extracurricular activity, and disparities between specific subject competence goals and the general core goals of the national curriculum could be attributed to a perception that core goals entail less obligation and represent broader educational aspirations in Norwegian schools (Sætre, 2016).

In conclusion, the studies mentioned in this literature review provide valuable insights into the integration of SDGs within various educational curricula, with a focus on both international and context-specific implementations. These studies were chosen for their relevance to understanding how sustainability education is approached in different educational systems, including early childhood and secondary levels. Each of these studies offers a unique perspective on the challenges and opportunities of embedding SD concepts into curricula in those respective countries either through environmental education, critical thinking, or action-based learning. The selection of these studies allows for a comparative analysis of how the UAE science curriculum for grades 1 to 4 can similarly incorporate the SDGs, ensuring that SD becomes an integral part of the educational experience. By drawing from diverse global examples, this research aims to identify best practices and potential gaps in the current representation of SDGs within UAE textbooks, providing a foundation for recommendations that could enhance the curriculum's alignment with global sustainability goals.

MATERIALS AND METHODS

This study aimed to explore how SDGs, considering relevant competencies (knowledge and understanding; skills and applications; values and attitudes), are reflected in the current UAE elementary school science curriculum (2022) and science textbooks for grades 1 to 4. The research questions related to this investigation were addressed through qualitative research, employing a case study methodology by applying content analysis to the curriculum objectives and the science textbooks. Qualitative research facilitates an in-depth understanding of problems or cases caused by individuals, groups, or society (Creswell, 1994). It enables a comprehensive appreciation of rich data, detailing nuanced contexts fully (Mason, 2002). In other words, "qualitative research is related to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things" (Lune & Berg, 2017).

The cases for this study encompassed the UAE elementary school science curriculum (2022) for grades 1

through 4 and their corresponding content from science textbooks. The case is defined as a bounded system, characterized by its limitations in time (2022), location (UAE), and context (the investigation of the elementary school science curriculum and science textbooks for grades 1 to 4). The textbooks for grades 1 to 4, approved by the UAE Ministry of Education, were utilized during the 2022-2023 academic year in the UAE.

Science Curriculum in the UAE

This study was conducted within the UAE science curriculum. There are several educational curricula in the UAE, most notably the ministerial curriculum, the American curriculum, and the British curriculum. The ministerial science textbooks are *McGraw Hill INSPIRE* science textbooks. The instructional language for science and mathematics curriculum at UAE schools is English. The UAE Ministry of Education adapted those science textbooks to the UAE context. Those science textbooks have been used in the UAE Ministry of Education public and private schools since 2016. This study focused on the cycle 1 *McGraw Hill INSPIRE* science curriculum and science textbooks of the Ministry of Education in the UAE. In 2018, the Ministry of Education amended the number of school grades in each stage cycle and made it from six to four. The basic level, also known as primary or elementary level/cycle 1 comprises of grades 1 to 4. The intermediate level/cycle 2 consists of grades 5 to 8 and the last level, which is the secondary level/cycle 3 includes grades 9 to 12 (Mullis et al., 2016).

The K to 4 *McGraw Hill INSPIRE* science textbooks in UAE provides a course in science that spans the first seven years of schooling, from kindergarten to grade 4. The curriculum is organized around the four scientific domains which are earth and space, life systems, energy systems, and matter. The curriculum focuses on what humans' need in order to live on earth, such as energy sources and uses, and the properties and behavior of common materials which are being spread as four units for each of the grades. The objectives of the K to 4 science curricula include developing in students an enriched view of themselves, their environment, and the future, and increasing student awareness of and enthusiasm for further scientific learning (Mullis et al., 2016). This curriculum is expected to help students develop proficiency in identifying and describing relationships between living things and describing energy sources. It is also expected that students will learn the importance of Earth as the source of most materials and understand the concept of sustainability and its importance.

Data Analysis

Stage 1. Review of sustainable development goals

The initial phase of the study involved a comprehensive review of the SDGs as outlined by the

United Nations (2015) and Sustainable Development Knowledge Platform (n. d.). This review served as an essential foundation for the research, offering a detailed background that informed the analytical steps that followed. The four SDGs (4, 6, 8 & 14) were chosen because this research project was part of the SDG research program initiated by the United Arab Emirates University for the 2022-2023 academic year, which focuses on four specific SDGs each year. Therefore, the selection of these four SDGs was driven by the requirements of the SDG Research Program. By examining the four specific SDGs and their related explanations, the research aimed to establish a robust contextual framework. This framework was crucial for understanding the scope and depth of the SDGs in relation to the educational objectives set forth in the 2022 elementary school science curriculum for grades 1-4.

The thorough examination of these goals provided insights into the global aspirations for SD and set the stage for identifying how these global objectives are mirrored and integrated within the curriculum. This in-depth review not only highlighted the direct alignment with the educational standards but also underscored the broader implications of embedding such goals into early science education, fostering a generation of students who are well-informed and motivated towards achieving sustainability.

Stage 2. Identification of SDG-related objectives in the 2022 elementary school science curriculum through content analysis

In this study, content analysis was employed to address the initial research question: Which objectives within the 2022 elementary science curriculum for grades 1-4 are related to SDGs? Content analysis is a research method that facilitates the extraction of knowledge regarding values, beliefs (whether conscious or unconscious), ideas, or attitudes of an individual or group (Fraenkel & Wallen, 2006). Artifacts for analysis can include documents or transcriptions in written form. Additionally, sources that have been transformed into text can be evaluated through content analysis (Berg, 2001). Successful content analysis necessitates an effective coding process (Hsieh & Shannon, 2005).

Weber (1990) posited that coding in content analysis allows for the categorization of information from the text into a more condensed form. Hsieh and Shannon (2005) noted that these categories may be patterns or themes emerging from the source material through analysis. The development of a coding scheme by the researcher is crucial for analyzing specified contexts within the identified categories. Categorization of information may occur prior to data analysis based on literature, related studies, etc., or during the data analysis process (Fraenkel & Wallen, 2006).

Identifying categories is vital for guiding the analysis and for translating the resulting information into meaningful units at the conclusion of the analysis process. The content analysis in this study was conducted using a rubric to identify the four SDGs, clusters of learning competences (knowledge and understanding; skills and applications; values and attitudes), and to define objectives in alignment with three aspects of SD during the curriculum objectives analysis. The analysis was performed by researchers, with expert opinions sought to make necessary revisions for the preparation of the final version.

Stage 3. Exploring corresponding contexts from science textbooks through document analysis

Document analysis, recognized as a qualitative research method (Bowen, 2009), allows for the examination, evaluation, and categorization of physical sources, especially written documents (Payne & Payne, 2004). It "yields excerpts, quotations, or entire passages from records, correspondence, official reports, and open-ended surveys" (Labuschagne, 2003). This study utilized document analysis to identify objectives related to the four SDGs within the 2022 elementary school science curriculum as reflected in science textbooks approved by the Ministry of Education. Through document analysis, Science textbooks for grades 1 to 4 were scrutinized, and the findings outlined the corresponding content from the textbooks related to SDG-aligned objectives. In both the content and document analysis processes of the elementary school science curriculum framework and the science textbooks, specific contexts related to SDGs were sought for each of the selected SDGs (4, 6, 8, & 15).

The primary analytical tool for this study was derived from "the curriculum framework for SDGs" (Osman et al., 2017) (**Appendix A**). This framework outlines three components constituting the competencies learners are to develop:

- (1) knowledge,
- (2) skills, and
- (3) values and attitudes.

These competencies are intrinsically linked and facilitate lifelong learning. The framework is designed as a matrix model, featuring core competencies indicative of the 17 SDGs, serving as an audit tool for these goals. From "the curriculum framework for SDGs," an analytical rubric was developed specifically for examining the selected four SDGs within this study.

The science curriculum framework underwent analysis by all participating researchers, while each science textbook for grades 1-4 was reviewed by two analysts to ensure analysis consistency. The analytical procedure commenced with a review of the four selected SDGs, proceeded with identifying SDG-related objectives in the 2022 elementary school science curriculum through content analysis, and concluded

with the exploration of corresponding contexts from science textbooks via document analysis. The consistency index among analyst pairs was determined using Cooper’s equation. Upon calculation, the agreement percentage between analysts was found to be 90%, indicating a high level of consistency in the analysis process (see **Appendix A** for examples of activities considered for the analysis).

To calculate the percentage of appearance of each of the four SDGs in both science curriculum framework as well as science textbooks, the authors follow the following formula to present data in numbers.

$$P = \sum \frac{n}{N} \times 100, \tag{1}$$

where *n* is the total number of pages that have related SDGs indicators of each document and *N* is the total number of pages of each document.

RESULTS

In this section, we will present the findings related to each research question.

Results related to research question 1. *Which objectives in the UAE elementary school science curriculum (2022) for grades 1-4 are aligned with the four SDGs (4, 6, 8, and 15)?*

Analysis of SDG Integration in the UAE Elementary School Science Curriculum Framework for Grades 1-4

Alignment of curriculum objectives with SDGs 4, 6, 8, and 15

In examining the alignment of the UAE cycle 1 elementary school science curriculum (2022) for grades 1 through 4 with four SDGs—namely, quality education (SDG 4), clean water and sanitation (SDG 6), decent work and economic growth (SDG 8), and life on land (SDG 15)—this analysis seeks to elucidate how these global objectives are integrated into the curriculum. The objective is to ascertain the curriculum’s contribution to fostering SD from an early educational phase, with a focus on the incorporation of these SDGs within the frameworks of knowledge and understanding, skills and application, and values and attitudes. The analysis aims to offer a detailed understanding of the curriculum’s focus on each SDG, demonstrating a deliberate strategy to incorporate SD into elementary education.

The analysis reveals that the content relevant to SDG 4 (quality education) in grade 1 is primarily situated within the domain of knowledge and understanding, showing scarce presence in the areas related to skills and application or values and attitudes. In subsequent grades, there is a marked increase in the coverage of SDG 4 through skills and application, with 63% in grade 2, 59% in grade 3, and 90% in grade 4, indicating a progression in learning expectations across the grades. For SDG 6 (clean water and sanitation), there is limited

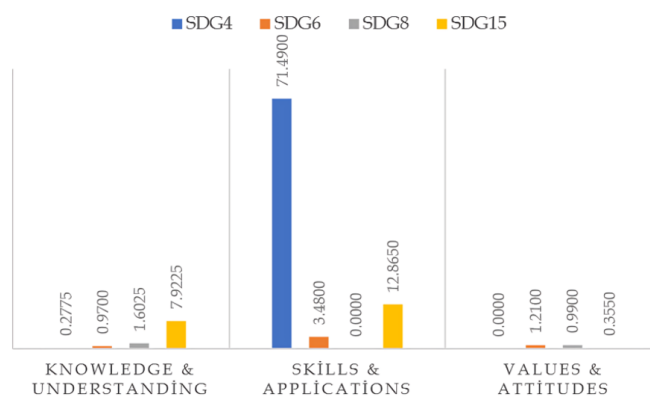


Figure 1. Average percentage of the four SDGs in curriculum framework-Grades 1-4 (Source: Authors’ own elaboration)

inclusion in grade 1 content across all three learning domains, a trend that persists across all grades. Similarly, SDG 8 (decent work and economic growth) exhibits minimal inclusion across any of the learning outcome areas in all grades. Regarding SDG 15 (life on land), an 18% representation is noted in grade 1 within knowledge and understanding. In grade 2, a higher representation is observed in skills and application (18%), with knowledge and understanding at 6%. This pattern continues in grade 3, with 9% for knowledge and understanding and 17% for skills and application. For grade 4, there is minimal coverage of SDG 15 across all learning areas (see **Appendix B**).

Figure 1 presents the average percentage representation of the four SDGs within the science curriculum framework across grades 1 to 4. As depicted in **Figure 1**, the distribution of learning outcomes in the science curriculum frameworks for all grades is as follows: For knowledge and understanding, the order of representation is SDG 15 (life on land) at 7.9225%, SDG 8 (decent work and economic growth) at 1.6025%, SDG 6 (clean water and sanitation) at 0.97%, and SDG 4 (quality education) at 0.2775%. In the domain of skills and applications, the percentages for the SDGs are as follows: SDG 4 at 71.49%, SDG 15 at 12.865%, SDG 6 at 3.48%, and SDG 8 at 0%. Lastly, for learning outcomes associated with Values and Attitudes, the representation percentages are SDG 6 at 1.21%, SDG 8 at 0.99%, SDG 15 at 0.355%, with no representation for SDG 4.

Results related to research questions 2. *What clusters of learning competencies (knowledge and understanding; skills and applications; values and attitudes) are identified for the four SDGs in the science curriculum for grades 1-4?*

Clusters of learning competencies for SDGs in grades 1-4

The findings related to the clusters of learning competencies for the four SDGs in the science curriculum for grades 1-4, indicate a targeted alignment within the curriculum framework for grades 1-4 (see **Appendix C**). **Appendix C** showcases the SDGs in

relation to the corresponding clusters of learning competencies and their learning outcomes.

For SDG 4, focusing on quality education, the curriculum framework for grade 1 represents learning outcomes related to three competencies under skills and applications: S1–demonstrate appropriate schooling behaviors; S4–learning to learn; and S5–critical and engaged approach toward learning. In the case of SDG 6, clean water and sanitation, the framework highlights a learning outcome related to one competency under knowledge and understanding: K8–basic understanding of water science–hydrology, the hydrologic cycle, and connection to climate change.

Similarly, SDG 8, decent work and economic growth, is represented by learning outcomes associated with one competency under knowledge and understanding: K1–job classifications. For SDG 15, life on land, the curriculum encompasses learning outcomes related to five competencies. Among these, K1–basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact; and K2–understand the importance of biodiversity and threats to biodiversity, habitat loss, concept of endangered species are under knowledge and understanding. The skills and applications are represented by S1–ability to communicate the importance of terrestrial ecosystems; S2–analyze impacts and risks associated with biodiversity loss and ecosystem degradation; and S3–beginning to apply systems thinking to understand ecosystem interdependencies, e.g., deforestation leads to habitat loss.

For grade 2 and concerning SDG 4, the curriculum framework includes learning outcomes related to three competencies. The first competency falls under knowledge and understanding, emphasizing the importance of learning (K3–why learning is important for my life), while the remaining competencies are categorized under skills and applications, focusing on S4–learning to learn; and S5–critical and engaged approach toward learning.

In the context of SDG 6, clean water and sanitation, the curriculum framework details learning outcomes associated with three competencies. The initial competency pertains to knowledge and understanding (K8–basic understanding of water science–hydrology, the hydrologic cycle, and connection to climate change), and the subsequent competencies are under skills and applications, covering S1–understanding and conscious water consumption; and S8–understanding how water interacts with environmental systems, dissolves, and moves substances underground.

Regarding SDG 8, decent work and economic growth, the curriculum framework for grade 2 delineates learning outcomes connected to three competencies. The first two competencies are under

knowledge and understanding, addressing K2–jobs in the school, community, etc., and K4–why people work. The third competency is categorized under values and attitudes, focusing on V4–finding positive solutions.

For SDG 15, life on land, the curriculum framework illustrates learning outcomes related to five competencies. The first two competencies are under knowledge and understanding, with a focus on K1–basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact; and K2–understand the importance of biodiversity and threats such as habitat loss and endangered species. The remaining competencies fall under skills and applications, including S1–ability to communicate the importance of terrestrial ecosystems; S2–analyze impacts and risks associated with biodiversity loss and ecosystem degradation; and S3–beginning to apply systems thinking to ecosystem interdependencies, e.g., deforestation leading to habitat loss.

For grade 3, and concerning SDG 4, the curriculum framework for grade 3 includes learning outcomes related to two competencies categorized under skills and applications: S4–learning to learn; and S5–critical and engaged approach toward learning. This highlights a concentration on developing autonomous learning skills and critical engagement with content. In the context of SDG 6, clean water and sanitation, the curriculum framework delineates learning outcomes across five competencies. The first competency is under knowledge and understanding, emphasizing K5–water resources and their utilization by humans (agriculture, industrial, domestic, recreational, fisheries). Two competencies are categorized under skills and applications: S6–ability to interpret common representations, such as maps of waterways; and S8–understanding how water moves through environmental systems. The final two competencies fall under values and attitudes, focusing on V6 and V8–both motivating change patterns of unsustainable consumption, which appears to be a repetition that might signify an emphasis on sustainability practices in water consumption (see **Appendix C**).

Regarding SDG 8, decent work and economic growth, the curriculum framework for grade 3 outlines learning outcomes associated with three competencies. The first two are under knowledge and understanding: K1–jobs in the school, community, etc., and K2–why people work, highlighting an understanding of employment and its social significance. The third competency falls under values and attitudes: V4–finding positive solutions, encouraging problem-solving in economic contexts. For SDG 15, life on land, the curriculum framework illustrates learning outcomes connected to five competencies. The initial competency under knowledge and understanding focuses on K1–basic understanding of ecosystems and human impact.

The next three competencies are under skills and applications: S1–ability to communicate the importance of terrestrial ecosystems; S2–analyze impacts and risks associated with biodiversity loss; and S3–applying systems thinking to ecosystem interdependencies, such as the effects of deforestation. The final competency falls under values and attitudes: V1–appreciation for conserving biodiversity, underlining the importance of environmental stewardship.

For grade 4, and concerning SDG 4, the curriculum framework includes learning outcomes associated with three competencies under skills and applications: S3–making connections between our own lives and those of others throughout the world; S4–learning to learn; and S5–critical and engaged approach toward learning. This focus underscores the development of empathy, autonomous learning skills, and critical engagement with learning content. Regarding SDG 6, clean water and sanitation, the curriculum framework outlines learning outcomes related to four competencies. The first three competencies are categorized under skills and applications, highlighting S3–understanding water scarcity and abundance; S4–conceptualizing water flowing through landscape-scale systems; and S8–understanding how water moves through environmental systems and interacts with other substances. The fourth competency falls under values and attitudes: V1–responsible and sustainable consumption, emphasizing the importance of sustainability in water consumption (see [Appendix C](#)).

Interestingly, for SDG 8, decent work and economic growth, the curriculum framework for grade 4 does not represent any learning outcomes related to the specified competencies, indicating a gap in the curriculum’s coverage of this SDG. Finally, in the case of SDG 15, life on land, the curriculum framework presents learning outcomes related to two competencies under skills and applications: S1–ability to communicate the importance of terrestrial ecosystems; and S3–beginning to apply systems thinking to ecosystem interdependencies, such as the relationship between deforestation and habitat loss. This representation highlights the curriculum’s emphasis on ecological awareness and systems thinking in understanding and addressing environmental challenges.

Results related to research question 3. *What are the learning outcomes associated with the SDGs’ learning competencies in the science curriculum for grades 1-4?*

Learning outcomes linked to SDGs’ learning competencies

To address this research question, the results showcasing the percentage representation of the four related SDGs within the science curriculum framework for grades 1-4 are depicted graphically in [Figure 2](#). [Figure 2](#) illustrates that the learning outcomes across

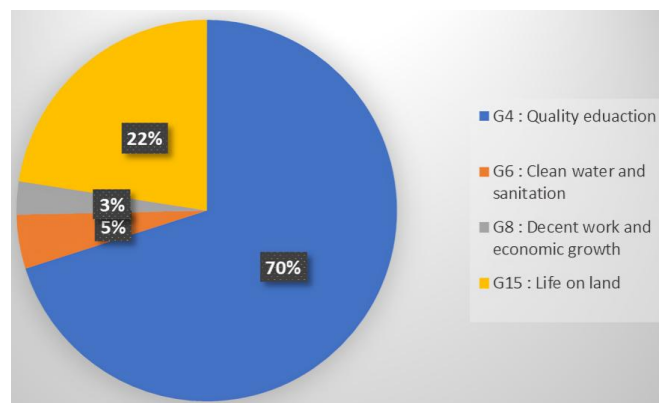


Figure 2. The percentage of representation of the four SDGs in the science curriculum framework–Grades 1-4 (Source: Authors’ own elaboration)

grades 1-4 are indeed aligned with the four targeted SDGs, albeit at varying levels of representation. Specifically, [Figure 2](#) delineates the distribution of representation for these SDGs in descending order of prevalence: SDG 4 (quality education) is the most represented, constituting 70% of the curriculum’s focus on SDGs; followed by SDG 15 (life on land), which accounts for 22%; SDG 6 (clean water and sanitation) comes next at 5%; and finally, SDG 8 (decent work and economic growth) has the least representation, at 3%.

Results related to research question 4. *How are the four SDGs distributed in relation to objectives across the three dimensions of ESD (economic, social, and environmental)?*

Distribution of SDGs across ESD dimension

To comprehensively address the research question concerning the distribution of the four related SDGs across the three dimensions of SD (economic, social, and environmental), detailed findings are presented for each grade within cycle 1. We meticulously outline how each of the four SDGs–emphasizing aspects such as quality education, clean water and sanitation, decent work and economic growth, and life on land–integrates with and contributes to the curriculum’s overarching framework of economic, social, and environmental sustainability. By examining the curriculum through the lens of these dimensions, the results offer a nuanced understanding of how the curriculum aims to foster a holistic comprehension of sustainability among students, ensuring they grasp the interconnectedness of these dimensions in addressing global challenges and achieving SD objectives (see [Appendix D](#)). The meticulous analysis of the alignment of learning outcomes within the science curriculum framework for grades 1-4 with the three dimensions of SD–economic, social, and environmental–across four pivotal SDGs: quality education (SDG 4), clean water and sanitation (SDG 6), decent work and economic growth (SDG 8), and life on land (SDG 15) has been elaborated below (see [Appendix D](#)). In the exploration of SDG 4 (quality education), a pronounced emphasis on the social

dimension is evident, beginning with a 24.32% representation in grade 1 and showing a gradual increase across the grades, culminating at 30% by grade 4. This trend underscores a consistent curriculum focus on the social aspects of SD, albeit without delving into its environmental or economic counterparts.

The curriculum's approach to SDG 6 (clean water and sanitation) and SDG 15 (life on land) primarily highlights the environmental dimension, with SDG 6 garnering a minimal 1.35% representation in grade 1 that slightly increases to 6% under the economic dimension by grade 4—a notable deviation that suggests an evolving curriculum focus. Conversely, SDG 15 maintains a steady emphasis on environmental considerations across all grades, although the representation slightly decreases to 2% in grade 4. Interestingly, a discrepancy is observed in the representation percentage for SDG 15 in grade 4, initially noted at 2% but later detailed as 5.424%, indicating a need for clarification. Meanwhile, SDG 8 (decent work and economic growth) exhibits minimal representation across the curriculum, signaling a potential area for further curriculum development to address economic sustainability more comprehensively. This comprehensive analysis not only sheds light on the curriculum's alignment with SDGs across different grades but also highlights areas of strength and opportunities for enhancing the integration of SD dimensions.

Analysis of UAE Elementary School Science Textbooks

Reflection of SDG-related objectives in science textbooks approved by the UAE Ministry of Education

In exploring how the four SDGs are integrated into the elementary school science curriculum (2022) and subsequently reflected in the science textbooks approved by the UAE Ministry of Education, a detailed analysis was conducted. The focus was on quantifying the extent to which these SDGs are represented in the textbooks used across grades 1 to 4. For this purpose, a total of 16 textbooks were reviewed—each grade is equipped with four textbooks, and each of these textbooks includes a unit dedicated to one of the SDGs, thereby ensuring comprehensive coverage across the board.

The findings from this analysis offer an average percentage representation of the four SDGs across the science textbooks designated for grades 1-4. This quantitative approach facilitates a clear understanding of the emphasis placed on each SDG within the curriculum's textbook materials, providing insights into the curriculum's alignment with global sustainability goals (see [Appendix E](#)).

In the analysis of how SDGs are reflected in UAE elementary science textbooks, distinct patterns of

representation were observed across grades 1 to 4. For SDG 4 (quality education), grade 1 textbooks prominently featured learning outcomes related to skills and applications, accounting for 48% of the content, with no coverage of knowledge and understanding or values and attitudes. This focus on skills and applications persisted through grades 2 to 4, with representation percentages at 31% for grade 2, peaking at 59% for grade 3, and returning to 32% for grade 4. The other two learning areas saw minimal representation for SDG 4 across all grades.

In grade 1, the focus is mainly on skills and applications, which account for 48% of the learning outcomes related to SDG 4. This emphasis on practical learning at such an early stage is notable, as it suggests a pedagogical approach that prioritizes active engagement and hands-on activities over theoretical knowledge or value-based education. However, the absence of coverage in knowledge and understanding and values and attitudes at this grade level raises questions about whether students are being provided with sufficient foundational knowledge or opportunities to develop ethical perspectives on education. While the focus on skills is valuable, the lack of attention to knowledge acquisition and value formation could limit students' holistic understanding of the importance of quality education as an SDG.

As we progress through grades 2 to 4, the curriculum continues to place a strong emphasis on skills and applications, though the representation fluctuates. In grade 2, 31% of the content is focused on this domain, followed by a peak in grade 3, where 59% of the learning outcomes are related to skills and applications. By grade 4, this value drops to 32%, indicating a return to a more balanced, though still skill-centered approach. The peak in grade 3 may reflect the curriculum's intention to encourage students to apply their learning in increasingly complex and sophisticated ways as they mature. The subsequent decline in grade 4 might suggest a shift in focus toward consolidating these skills, rather than introducing new applications.

The domain of values and attitudes is also underrepresented in relation to SDG 4 across all grades. This limited focus suggests that there may not be sufficient address of the ethical and moral dimensions of education, such as the importance of fairness, inclusivity, or the intrinsic value of lifelong learning. Without paying attention to values and attitudes, students may miss opportunities to cultivate a personal commitment to the principles of quality education.

SDG 6 (clean water and sanitation) saw no learning outcomes represented in grade 1 textbooks. This omission in the earliest grade level suggests that the curriculum may initially prioritize other SDGs or foundational knowledge, potentially delaying students' early exposure to water-related sustainability issues.

Considering the significance of clean water and sanitation in both global sustainability and students' everyday lives, the absence of SDG 6 at this foundational stage represents a missed opportunity to introduce young learners to these crucial concepts. From grade 2 onwards, there was a gradual introduction of content related to SDG 6, particularly in the "skills and applications" domain. In grade 2, 3% of the learning outcomes focus on this competency, indicating a tentative step towards incorporating practical knowledge about clean water and sanitation. This progression continues in grade 3, where the representation of "skills and applications" increases to 6%, reflecting a greater emphasis on engaging students with the practical aspects of water conservation and sanitation. The growing focus on "skills and applications" can aid to introduce students to hands-on activities and real-world applications of sustainable water management. These activities involve observations, experiments, inquiry activities or problem-solving tasks that help students better understand how clean water is maintained and how sanitation practices are applied in different contexts. Interestingly, in grade 4, the representation of SDG 6-related content in the "skills and applications" domain reverts to 3%, mirroring the percentage observed in grade 2. This decline after an increase in grade 3 suggests a potential shift in focus as students approach the transition to higher grades, where other sustainability goals or competencies might take precedence.

SDG 8 (decent work and economic growth) presented a diverse representation in grade 1 textbooks across all learning areas: 5.02% in knowledge and understanding, 5.96% in skills and applications, and 2.54% in values and attitudes. In grade 2, learning outcomes were found in knowledge and understanding (4%) and values and attitudes (6%), but not in skills and applications. Grades 3 and 4 showed a consistent pattern of representation, with knowledge and understanding at 6% and values and attitudes at 9%.

In grade 1, SDG 8 is represented across all three learning domains—"knowledge and understanding", "skills and applications", and "values and attitudes"—with 5.02% in knowledge and understanding, 5.96% in skills and applications, and 2.54% in values and attitudes. The presence of skills and applications in grade 1 is particularly notable, as it indicates an early focus on applying knowledge about work and economic growth through activities and practical exercises thus trying to prioritize a well-rounded approach to SDG 8, exposing younger students to basic economic concepts, skill-building, and attitudes related to work ethics and economic participation.

Across grades 2 to 4, the representation of SDG 8 in the "knowledge and understanding" domain remains relatively consistent, with 6% of the content dedicated to this competency in grades 3 and 4, and a slightly lower

4% in grade 2. This stability suggests that there is a steady focus on imparting theoretical knowledge about decent work and economic growth as students advance through the grades.

However, a marked change is observed in grade 2, where skills and applications are entirely absent, despite a continued focus on knowledge and understanding (4%) and an increased emphasis on values and attitudes (6%). This reduction in skill-based learning for SDG 8 in grade 2 is an important trend, as it suggests that the curriculum shifts away from hands-on learning and application, focusing more on theoretical knowledge and ethical perspectives related to decent work.

In grade 3 and grade 4, there is a clear trend of increasing emphasis on values and attitudes related to SDG 8. In both grades, 9% of the learning outcomes are focused on fostering students' attitudes toward work and economic growth. This increased emphasis on values and attitudes at higher grade levels is likely aimed at encouraging students to reflect more deeply on the societal and personal implications of decent work and economic growth. It aligns with the broader educational goal of preparing students to think critically about their roles as future workers and contributors to economic sustainability.

Another key observation across the grade levels is the inconsistency in the skills and applications domain related to SDG 8, which is present in grade 1 but absent in grade 2, and not mentioned for grade 3 and grade 4. This inconsistency in skill-building related to SDG 8 represents a critical gap, as practical skills are essential for students to understand and apply economic principles in real-world contexts.

For SDG 15 (life on land), the grade 1 textbooks significantly covered learning outcomes related to knowledge and understanding (32.93%), followed by skills and applications (5.22%) and values and attitudes (2.24%). In subsequent grades, the representation decreased, with skills and applications seeing the highest percentages in grade 3 and grade 4 (17% and 11%, respectively). Knowledge and understanding was represented at 14% in grade 2 and maintained at 9% for grade 3 and grade 4.

Grade 1 stands out with a substantial representation of SDG 15 content, particularly in the knowledge and understanding domain, where 32.93% of the learning outcomes are dedicated to life on land. This early emphasis suggests that the curriculum prioritizes foundational knowledge related to biodiversity, ecosystems, and environmental conservation at the earliest stage of education. Such a strong focus on knowledge and understanding in grade 1 likely aims to instill basic awareness of environmental concepts, which are crucial for young learners to grasp the significance of sustaining life on land.

However, the relatively low representation of skills and applications (5.22%) and values and attitudes (2.24%) in grade 1 indicates that the focus at this stage is primarily on theoretical knowledge, with limited engagement in practical activities or the development of environmental ethics. This could suggest that while students are introduced to the concepts of biodiversity and ecosystems, there is less emphasis on hands-on activities or the cultivation of attitudes toward protecting life on land. This gap may impact how well students internalize the importance of sustainability beyond factual understanding.

A notable trend is the decline in representation of knowledge and understanding in subsequent grades. From 32.93% in grade 1, the coverage drops to 14% in grade 2 and further decreases to 9% in grade 3 and grade 4. This reduction may suggest that as students' progress through the elementary grades, the curriculum shifts its focus away from imparting knowledge about life on land. In contrast to the decline in knowledge and understanding, there is a marked increase in the representation of skills and applications for SDG 15 in the higher grades. From 5.22% in grade 1, the coverage rises significantly to 17% in grade 3 and 11% in grade 4. This upward trend suggests a curriculum focusing on practical learning and problem-solving activities related to life on land. The activities associated involve experiments, observations and projects related to ecosystems, plant and animal life, and environmental conservation, encouraging students to apply their knowledge in practical settings.

Trends in the progression of SDG coverage and competency development across the grade levels: The overall trend in the progression of SDG 4 coverage across grade 1 to grade 4 reveals a consistent prioritization of skills and applications, with fluctuations in intensity but minimal inclusion of knowledge and understanding and values and attitudes. This suggests a curriculum that is heavily skill-oriented but lacks depth in both content knowledge and value formation. While students are likely developing strong practical abilities related to problem-solving in education, they may not be gaining the conceptual understanding or ethical grounding necessary to fully appreciate the importance of SDG 4. This gap could limit their ability to connect their practical learning experiences with broader societal and global educational challenges, thereby reducing the long-term impact of their education on SD.

When considering SDG 6 across all grades (1 to 4), it is consistently underrepresented in terms of knowledge, skills, and values and attitudes. The lack of coverage is notable, as water scarcity and sanitation are global issues with particular relevance in the UAE, where sustainable water management is critical. This consistent gap across grade levels suggests that SDG 6 does not feature as a key priority in the elementary science curriculum, indicating an area where significant curriculum

development is needed. A broader focus on water sustainability could provide students with crucial environmental literacy that prepares them for addressing pressing global challenges related to water.

The analysis reveals a mixed approach to SDG 8 coverage across grades 1 to 4, with early emphasis on both knowledge and practical skills in grade 1, a shift towards values and attitudes in the higher grades, and an overall lack of consistent skill development. This progression suggests that while the curriculum is increasingly focusing on ethical considerations related to decent work and economic growth, it is not fully addressing the practical competencies students need to navigate economic challenges.

The progression of SDG 15 coverage and competency development across the elementary grades reveals a clear trend: where there is a strong emphasis placed on knowledge and understanding in grade 1, and there is a shift toward skills and applications in the higher grades, with values and attitudes receiving limited attention throughout. This progression highlights both strengths and gaps in the curriculum's approach to teaching SD, particularly in terms of balancing theoretical knowledge, practical skills, and ethical values.

To strengthen the curriculum's impact on sustainability education, future revisions could aim to ensure a more balanced representation of all three learning domains in all the four considered SDGs. Increasing the focus on values and attitudes would help cultivate a deeper ethical commitment to environmental stewardship among students. Furthermore, future research could investigate how this progression in these four SDGs (4, 6, 8, 15) coverage compares to other SDGs and explore whether similar trends are observed in higher grades or across other subject areas. Such studies could offer valuable insights into the broader integration of SD in the UAE education system and contribute to the global discourse on education for sustainability.

SDG-related activities distribution by grade in MOE-approved textbooks

To explore the distribution of activities related to the four SDGs across science textbooks by grade, a detailed breakdown of how these activities are integrated within the educational content (see **Appendix F**). This analysis aims to understand the emphasis placed on SDGs 4 (quality education), 6 (clean water and sanitation), 8 (decent work and economic growth), and 15 (life on land) in relation to the total number of activities presented in the textbooks.

For SDG 4, the focus within grade 1 textbooks is on learning outcomes associated with three competencies under the cluster of skills and applications: S3-Making connections between our own lives and those of others around the world; S4-Learning to learn; and S5-Adopting a critical and engaged approach towards

learning. For example, in unit 1 of grade 1, which covers the topic “all about plants,” the lesson emphasizes hands-on activities. On page 4, students are prompted with questions such as “What does a landscape architect do?” and “What do landscape architects need to know about plants?” This aligns with the learning competencies S3 (making connections between our lives and those of others around the world), S4 (learning to learn), and S5 (adopting a critical and engaged approach to learning) as outlined in the analysis rubric for SDG 4. (see [Appendix G](#)). This suggests a strong emphasis on developing interpersonal skills, self-directed learning, and critical thinking in relation to quality education. In contrast, SDG 6 does not have any learning outcomes related to its competencies represented in the grade 1 textbooks, indicating a gap in coverage for clean water and sanitation topics at this educational level.

For SDG 8, the textbooks offer a more diverse representation of learning outcomes, encompassing knowledge and understanding (K1–Job classifications; K2–Jobs in the school, community, etc.; K4–Why people work), skills and applications (S1–Explain different kinds of jobs in other parts of the world), and values and attitudes (V1–Appreciation of the multifaceted nature of the world/surroundings; V2–Valuing the resources and services available; V4–Appreciation of the multifaceted nature of the world/surroundings). This variety indicates a comprehensive approach to introducing students to the concepts of work, employment, and economic activity from multiple perspectives. For example, in grade 1, unit 3 textbook, which discusses the topic “sky patterns”, page no 4 depicts “What does an astronomer do?” and further gives an activity for the students to think about “what they think astronomers need to know about outer space? and why do they think it is important to study objects in outer space?” In fact, both these questions clearly reflect all the learning outcomes of knowledge and understanding, skills and applications and values and attitudes, which are mentioned above (see [Appendix H](#)).

Lastly, SDG 15 is represented through learning outcomes that cover knowledge and understanding (K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and the consequences of human impact; K2–Understanding the importance of biodiversity and threats such as habitat loss and endangered species), skills and applications (S1–Communicating the importance of terrestrial ecosystems; S2–Analyzing impacts and risks associated with biodiversity loss and degradation; S3–Applying systems thinking to ecosystem interdependencies, e.g., deforestation leads to habitat loss), and values and attitudes (V2–Understanding the rights of other species and valuing species interdependence). This indicates a holistic approach to teaching about life on land, incorporating both scientific knowledge and ethical considerations. For example, in grade 1, unit 2 textbook,

discussing the topic “animals and how they communicate”, page no 9 depicts an activity encouraging children to enquire about “which structure will help different birds to catch their food?” which will help them understand the differences and similarities between how different creatures are created (see [Appendix H](#)).

Through presentation of the findings (see [Appendix E](#)), it becomes clear that while there is a varied level of engagement with the SDGs across different learning domains in grades 1-4 science textbooks, certain areas—particularly clean water and sanitation—may require further emphasis to achieve a balanced integration of all targeted SDGs.

An in-depth look at how activities related to the four SDGs are distributed within grade 2 science textbooks has been carried out, thus offering insights into the curriculum’s focus areas (see [Appendix E](#)). For SDG 4 (quality education), grade 2 textbooks cover learning outcomes linked to four competencies, including K4–What I want to be when I leave school, highlighting future aspirations; S3–Making connections between our own lives and those of others around the world, fostering global awareness; S4–Learning to learn, emphasizing the development of autonomous learning skills; and S5–Critical and engaged approach towards learning, encouraging deep engagement with learning material. For example, in grade 2, unit 1, page 18 explains “What does a land surveyor do?” and includes information about a renowned land surveyor. The following lesson on page 22 features an activity that prompts students to envision themselves as land surveyors, tasked with identifying a suitable location for a new airport in their town and drawing a map of that area. This activity emphasizes all four competencies mentioned earlier by fostering future aspirations and promoting inquiry-based learning (see [Appendix H](#)). Furthermore, the exploration into SDG 6 (clean water and sanitation) reveals a comprehensive representation of five learning outcomes, such as S1–Understanding and conscious water consumption and S4–Conceptualizing water flowing through landscape-scale systems. This indicates a strong emphasis on environmental science, specifically water resource management, and conservation within the curriculum. These competencies extend to S5–Applying understanding of watershed structures, S6–Interpreting common representations, like maps of waterways, and understanding the movement of water and its interactions within environmental systems. In grade 2, unit 1, centered on “land and water,” lesson 3 covers the topic “water on earth” and includes an “inquiry activity” that encourages students to observe and identify patterns in various water forms. The textbook also offers concise explanations of different bodies of water (see [Appendix H](#)). For SDG 8 (decent work and economic growth), grade 2 textbooks incorporate four learning

outcomes, with three focusing on knowledge and understanding (K1–Job classifications, K2–Jobs in the school, community, etc., K4–Why people work) and one on values and attitudes (V1–Appreciation of the multifaceted nature of the world/surroundings), reflecting an effort to blend knowledge about work with appreciation for diverse global contexts.

Lastly, SDG 15 (life on land) is addressed through outcomes related to knowledge and understanding (K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and the consequences of human impact; K2–Understanding the importance of biodiversity and threats such as habitat loss and endangered species) and skills and applications (S2–Analyzing impacts and risks associated with biodiversity loss and ecosystem degradation; S3–Applying systems thinking to understand ecosystem interdependencies, e.g., deforestation leads to habitat loss). This showcases the textbooks’ commitment to environmental education, focusing on ecosystem health and biodiversity. Overall, we illustrate the grade 2 science textbooks’ structured approach to integrating the SDGs, highlighting a balanced mix of knowledge acquisition, skill development, and value formation across the domains of education, water sanitation, economic growth, and environmental preservation. For example, in grade 2, unit 4, page 12 explains how plants obtain their food, including how those in dark environments manage to survive. This is followed by an “inquiry activity” that helps students understand the importance of sunlight for plant survival. Additionally, on Page 28, the lesson discusses the interdependence of plants and animals for their survival (see [Appendix H](#)).

A detailed analysis of how activities related to the SDGs are woven into the fabric of science textbooks for grade 3, illustrating the curriculum’s alignment with global sustainability objectives has been carried out (see [Appendix E](#)). For SDG 4 (quality education), grade 3 textbooks focus on three specific learning outcomes within the skills and applications domain: S2–Identifying personal learning needs for development, S4–Learning to learn, and S5–Engaging critically with learning material. This emphasis on self-awareness, learning autonomy, and critical engagement highlights a comprehensive approach to fostering quality education through skill development.

Moving to SDG 6 (clean water and sanitation), the textbooks showcase three learning outcomes aimed at enhancing students’ understanding and consciousness about water consumption (S1), fostering a deeper understanding of water-related issues to inspire behavioral changes (S2), and conceptualizing how water flows through various systems (S4). This targeted focus underscores the curriculum’s commitment to instilling environmental stewardship among students, particularly regarding water resources.

In the context of SDG 8 (decent work and economic growth), three learning outcomes are highlighted, covering both knowledge and understanding–K1 (job classifications), K2 (jobs in the school, community, etc.)–and values and attitudes with V4 (why people work), reflecting a balanced approach to exploring the facets of economic growth and the value of work. For instance, in grade 3, unit 4, page 15 explains “What does a broadcast meteorologist do?” and includes an “inquiry activity” that invites students to use weather maps and other resources to write and present a weather forecast. This activity aligns with the learning outcomes of SDG 8 (see [Appendix H](#)).

For SDG 15 (life on land), the textbooks for grade 3 are particularly rich in content, presenting five learning outcomes that span knowledge and understanding–K1 (basic understanding of forest and freshwater ecosystems, ecosystem health, and human impact), K2 (understanding the importance of biodiversity and threats like habitat loss and endangered species)–and skills and applications–S1 (communicating the importance of terrestrial ecosystems), S2 (analyzing biodiversity loss and ecosystem degradation), S3 (applying systems thinking to ecosystem interdependencies, such as how deforestation leads to habitat loss). This broad coverage ensures a thorough exploration of environmental issues, aiming to cultivate a deep appreciation for and understanding of life on land. In grade 3, unit 3, lesson 1 focuses on the survival of organisms, such as plants, birds, and animals, while examining their adaptations and variations. This lesson includes an “inquiry activity” on page 26, prompting students to observe how birds with different beak shapes gather food. Through this activity, students learn how the design of a bird’s beak affects its ability to collect different kinds of food (see [Appendix H](#)). Overall, the findings reveal the grade 3 science textbooks’ strategic integration of SDG-related activities, demonstrating a commitment to equipping students with the knowledge, skills, and attitudes necessary to navigate and contribute positively to the world. Through a mix of educational strategies, these textbooks aim to address key aspects of quality education, water sanitation, economic growth, and environmental preservation, reflecting the interconnected nature of these global goals.

The integration of activities associated with the SDGs within grade 4 science textbooks has also been outlined (see [Appendix E](#)) providing a comprehensive view of the curriculum’s engagement with these global objectives. Specifically, for SDG 4 (quality education), grade 4 textbooks showcase a total of six learning outcomes, with a significant focus on skills and applications: S1–Demonstrating appropriate schooling behaviors; S2–Identifying personal learning needs for development; S3–Making connections between personal experiences and those of others globally; S4–Learning to learn; and S5–Engaging critically with learning material.

Additionally, K4–What I want to be when I leave school, representing knowledge and understanding, adds a future-oriented dimension to the quality education goal.

Regarding SDG 6 (clean water and sanitation), the textbooks for grade 4 detail six learning outcomes, balancing between values and attitudes–V1 (valuing and appreciating available resources and services) and V2 (motivation for changing unsustainable consumption patterns)–and skills and applications. The latter includes S4 (conceptualizing water movement through systems), S5 (applying watershed structure understanding), S6 (interpreting maps of waterways), and S8 (understanding water’s interaction within environmental systems), thereby emphasizing a multifaceted approach to water conservation and management. For instance, in grade 4, unit 3, lesson 1 covers the topic of “earth and its changing features,” providing a detailed explanation of earth’s ocean features on page 14. The lesson also explores various patterns in the distribution of earth’s geographical features. Additionally, on page 5, there is a lesson launch activity focused on discussing land and water features (see [Appendix H](#)). For SDG 8 (decent work and economic growth), seven learning outcomes are highlighted, with four emphasizing knowledge and understanding: K1 (job classifications), K2 (jobs in the school, community, etc.), K3 (pPeople who provide care), and K4 (understanding the motivations behind work). The remaining three outcomes focus on values and attitudes: V1 (appreciating the world’s complexity), V2 (valuing resources and services), and V4 (finding positive solutions), which collectively foster a nuanced understanding of economic activities and their societal impact. In grade 4, unit 4, there are references to various professions, such as a physical geographer (on page 20) and a paleontologist (on page 36). Additionally, the unit includes activities designed to help students envision themselves in these roles, fostering the development of problem-solving skills (see [Appendix H](#)). This detailed presentation of analyses not only underscores the grade 4 science textbooks’ alignment with the SDGs but also illustrates the curriculum’s holistic approach to education. By incorporating a diverse array of learning outcomes across the domains of skills and applications, knowledge and understanding, and values and attitudes, the textbooks aim to equip students with the necessary competencies, awareness, and perspectives to navigate and contribute positively to a sustainable future (see [Appendix E](#)).

Integration of SDGs within ESD dimensions in UAE textbook content by grade

Exploring the intricate relationship between the SDGs and the three dimensions of SD (economic, social, and environmental) as represented in science textbooks across different grade levels, we serve as a foundational document. We outline the distribution of four pivotal

SDGs–Quality education (SDG 4), clean water and sanitation (SDG 6), decent work and economic growth (SDG 8), and life on land (SDG 15)–across the economic, social, and environmental dimensions of SD within the UAE science curriculum.

The data (see [Appendix F](#)) highlights a pronounced emphasis on the social dimension across all grades, particularly for SDG 4 (quality education), where the social emphasis steadily increases from 24% in grade 1 to 30% by grade 4. This trend underscores a consistent curriculum focus on fostering social awareness and skills crucial for quality education. In contrast, the economic and environmental dimensions receive more varied attention across the SDGs and grade levels. For instance, SDG 6 (clean water and sanitation) sees an initial focus on the environmental dimension with a slight increase in grade 4, where a 6% emphasis on the economic dimension emerges, indicating a nuanced approach to teaching about water resources and sustainability.

SDG 8 (decent work and economic growth) and SDG 15 (life on land) also reveal interesting patterns; while SDG 8 receives a minimal but notable 1.35% to 2% focus on the economic dimension in grade 1 and grade 3, respectively, SDG 15 is predominantly emphasized within the environmental dimension across all grades, highlighting the curriculum’s commitment to environmental education and awareness.

The structured approach to integrating the SDGs within the UAE science textbooks, (see [Appendix F](#)), illustrates a strategic curriculum design that aims to balance the educational content across the economic, social, and environmental dimensions of SD. By doing so, the curriculum not only adheres to global sustainability objectives but also ensures that students are well-equipped with the knowledge, skills, and values necessary to navigate and contribute positively to a sustainable future. This comprehensive distribution underscores the importance of a holistic educational framework that prepares students to meet the challenges of SD with a well-rounded understanding of its multifaceted nature.

DISCUSSION

ESD equips individuals with perspectives on value, ethics, foresight, and long-term decision-making concerning our future. Education can facilitate the acquisition of necessary knowledge and behaviors related to SD. Furthermore, curricula can enable students to acquire competencies associated with the SDGs. The literature underscores that the recommendations of the majority of studies conducted advocate for appropriate SDG-related learning outcomes for students and advocate for an increase in SDG-related learning outcomes in the Earth and Universe domains.

Globalization and national development traditions shape the contextualization of ESD and SD at the national level. Massive global challenges influence both our present and our future. The UN and the United Nations Educational, Scientific and Cultural Organization have emphasized the significance of the SDGs, urging educational systems worldwide, including those in the UAE, to incorporate them. The UAE government supports the UN and the United Nations Educational, Scientific and Cultural Organization (UNESCO) policies promoting the SDGs. The UN' agenda 2030, formally adopted at the UN Sustainable Development Summit in September 2015, aims to address global concerns, requiring education in general and the science curriculum, in particular, to address issues such as climate change, biodiversity loss, and water shortages. At this summit, the UAE underscored the importance of access to clean energy, alongside sufficient and affordable food, quality education and healthcare, sustainable economic growth, healthy ecosystems, and increased resource efficiencies. The UAE government has aligned SDG targets with federal agencies within the national committee. For instance, the Ministry of Education is advancing targets in SDG 4, the Ministry of Energy and Industry is focusing on SDG 6 targets, the Ministry of Human Resources & Emiratization is advancing SDG 8 targets, and the Ministry of Climate Change & Environment is addressing SDG 15 targets.

Few studies have examined the implementation of the SDGs in mainstream curricula in the UAE (Berglund et al., 2020). Our study investigated how the selected four SDGs (4, 6, 8, and 15) and their relevant competencies (knowledge and understanding; skills and applications; values and attitudes) are incorporated into the current UAE elementary school science curriculum framework and school science textbooks for grades 1 to 4. A qualitative case study methodology guided the data collection process, employing content analysis for the curriculum framework's objectives and document analysis for the science textbooks to illustrate the integration of SDG-related objectives.

The elementary science curriculum framework and school science textbooks from grades 1 to 4 were selected for analysis because science education, with its interdisciplinary structure encompassing biology, chemistry, physics, astronomy, and geology, plays a crucial role in developing individuals capable of addressing both daily and global SD challenges, such as biodiversity loss and disaster reduction (Tatlioğlu, 2019). Moreover, the elementary school stage is pivotal in instilling basic values, attitudes, skills, behaviors, and habits that support SD, which may have long-lasting effects, such as the wise use of resources, cultural diversity, gender equality, and democracy. Research indicates that racial stereotypes are learned early and

that young children are capable of absorbing cultural messages about wealth and inequality (UNESCO, 2008).

The results from the content analysis of the Science curriculum framework indicate a significant representation of skills and applications related to SDG 4 (quality education) across all four grades. There is also a moderate representation of knowledge and understanding, as well as skills and applications related to SDG 15 (life on land), with minimal to no representation for SDG 6 (clean water and sanitation) and SDG 8 (decent work and economic growth) at times. Furthermore, the analysis concerning the distribution of the four relevant SDGs according to the three dimensions of SD—social, economic, and environmental—revealed an incomplete representation of all three dimensions for any of the SDGs across the grades. Specifically, the social dimension was represented in SDG 4, the economic dimension in SDG 8, and the environmental dimension primarily in SDG 15 and occasionally in SDG 6.

The document analysis of science textbooks from grade 1 to grade 4 showed a similar pattern to the curriculum framework analysis. Skills and applications of SDG 4 were most represented across all grades, followed by a medium representation of knowledge and understanding of SDG 15, and minimal representation of the learning competencies of SDG 6 and SDG 8. The activities within the textbooks reflected a similar distribution, emphasizing SDG 4. The representation of SD dimensions in the science textbooks demonstrated the social dimension in SDG 4, the economic dimension in SDG 8, and the environmental dimension in SDG 15 and SDG 6.

Overall, SDG 4 (quality education) is the most represented goal among the selected SDGs in both the science curriculum framework and textbooks, followed by SDG 15 (life on land). SDG 6 (clean water and sanitation) and SDG 8 (decent work and economic growth) are the least represented. The study recommends that the Ministry of Education include more learning outcomes related to the competencies (skills and applications, and values and attitudes) for SDG 6 and SDG 8 to ensure an effective vertical organization of SDG-related content at each learning stage.

Water resources are crucial for development in areas such as food security, health promotion, and poverty reduction, contributing to economic growth in agriculture, industry, energy generation, and maintaining healthy ecosystems. Given the UAE's location in a particularly arid region with limited renewable water resources, it is imperative to include learning outcomes related to the competency (values and attitudes) of SDG 6. This inclusion would help students understand water issues in the UAE and

globally and acquire skills to develop sustainable water consumption patterns and lifestyles.

SDG 8 aims to promote inclusive economic development, improve productivity levels, and foster employment and entrepreneurship opportunities. The UAE has implemented laws, policies, and awareness campaigns to improve working conditions across the public sector, private sector, and free zones. To support this further, the inclusion of more learning outcomes related to SDG 8 in the science curriculum and textbooks is crucial, especially those related to skills and applications, and values and attitudes that address solutions for inequality and foster an appreciation for the complex nature of the world. Additionally, the inclusion of more learning outcomes related to the competency of values and attitudes of SDG 4 is recommended.

CONCLUSIONS

The purpose of this study was to examine how the four SDGs and their associated competencies are integrated into the current UAE elementary school science curriculum (2022) and science textbooks for grades 1 to 4 (Ministry of Education, 2024). A content analysis methodology was applied to evaluate the objectives of the science curriculum, and document analysis was utilized to scrutinize the science textbooks, aiming to ascertain how objectives related to SDGs are addressed. The analysis of both the science curriculum framework and the textbooks across grade 1 to grade 4 revealed notable parallels.

The curriculum acts as a fundamental conduit for imparting knowledge and awareness to students. This study identified shortcomings within the curriculum, notably a significant discrepancy in adequately encompassing all SDGs. Specifically, SDG 4 (quality education) and SDG 15 (life on land) received high to moderate coverage, respectively, whereas SDG 6 (clean water and sanitation) and SDG 8 (decent work and economic growth) were minimally covered or nearly omitted. It is crucial to prioritize ESD and undertake initiatives to incorporate the overlooked SDGs into the educational framework. Educators are pivotal in preparing students for future challenges. To foster SD, the curriculum must be continually enhanced, updated, and revised. Learning outcomes should be meticulously aligned with the SDGs, ensuring adequate representation at every grade level. Efforts should be directed towards amending learning outcomes to rectify deficiencies and fill gaps within the science curriculum, thus promoting the achievement of SDGs.

This study acknowledges certain limitations. Firstly, the elementary science curriculum framework and science textbooks for grades 1-4 do not encapsulate the complete representation of SDGs in the UAE's education system. A more comprehensive investigation into curriculum frameworks across various educational

levels, including higher education, is essential to fully understand the national portrayal of SDGs in the UAE's educational landscape. Secondly, this research focused solely on four SDGs, suggesting that future studies should expand to include other SDGs. Further research could enrich our understanding, offering additional empirical evidence on SDG-related curricula and pedagogical practices. Given Wals's (2011) recommendation for increased research on ESD, there is optimism for future studies to support or critique the SDGs, thus facilitating global comparisons and discussions.

Moreover, while science education plays a crucial role in promoting sustainability-related goals, other subjects, such as social studies, mathematics, and language arts, could also provide significant insights into how SDGs are integrated across the curriculum. A more comprehensive analysis encompassing multiple subjects and educational levels (as mentioned previously)—including middle school, high school, and higher education—would also allow for a deeper understanding of how the UAE's education system addresses SDGs across the spectrum of learning. However, the issue of subjectivity was eliminated in this study since there was timely consistency monitoring conducted during the whole analysis process to improve reliability. Additionally, the significance of this study is underscored by its originality, as no prior research has been conducted in the UAE that examines both the curriculum framework and science textbooks within the cycle 1 education system.

Analyzing curriculum frameworks in terms of SDGs is essential for global educational institutions as they move forward with the trend of sustainability with the aim of achieving the 2030 agenda for SD. Education is a powerful tool for shaping the future and integrating SDGs into curriculum frameworks which ensures that students develop the knowledge, skills, values, and attitudes necessary to address global challenges such as climate change, inequality, and resource depletion. Particularly, the UAE's efforts to integrate sustainability into its education system can serve as a model for other countries, but it is clear that more work as previously mentioned is needed to fully realize this vision. Future studies could contribute to global comparisons and discussions on best practices for implementing ESD. As the demand for green skills and sustainability leadership increases globally, this study is also a recommendation for all educational institutions to critically analyze their curricula and adapt to meet these evolving needs. Institutions that fail to do so may risk falling behind in an era where sustainability is increasingly shaping policy, economic practices, and social values worldwide.

In conclusion, the analysis of curriculum frameworks in terms of SDGs is a crucial step for global educational institutions to remain relevant and impactful in today's world. The UAE's forward-thinking approach serves as

a successful model for other nations, showcasing the potential of education to support SD and foster global citizens who are ready to tackle the world's most pressing challenges. Moving forward, this trend will only grow in importance, making it imperative for educational leaders worldwide to prioritize SDGs in their curriculum planning and execution.

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APPENDIX A

Table A1. SDGs content analysis rubric for the selected four SDGs (Osman et al., 2017)

Goal 4-Quality education

Knowledge and understanding

- K.1.My right to schooling
- K.2.My responsibility to work hard
- K.3.Why learning is important in my life
- K.4.What I want to be when I leave school
- K.5.Education in other parts of the world
- K.6.Introduction to the SDGs as a set of targets with the aim of ending extreme poverty for everyone and tackling climate change

Skills and applications

- S.1.Demonstrate appropriate schooling behaviors
- S.2.Identify own learning needs for personal development
- S.3.Make connections between our own lives and those of others throughout the world
- S.4.Learning to learn
- S.5.Critical and engaged approach toward learning

Values and attitudes

- V.1.Self-disciplined, self-reliant and integrated citizen
 - V.2.Values of gratitude and appreciation
 - V.3.Rights and responsibilities
 - V.4.Valuing quality education for all
 - V.5.Appreciate access to education
 - V.6.Empathy with children who do not have access to schooling
 - V.7.Appreciation and respect for diversity
-

Goal 6-Clean water and sanitation

Knowledge and understanding

- K.1.Use of water in domestic activities for cleanliness, hygiene, relaxation and food preparation, and formation of daily habits, routines, and lifestyles
- K.2.Deconstructing the routines, habits, and lifestyles in which water plays a part, and the influence of peers, family, and social norms on water use
- K.3.Principle of water abundance v. water scarcity, both physical and economic, and as a finite resource
- K.4.Potential effects of dirty water: poor health, increased hunger, poverty, and lack of access to education
- K.5.Water resources and utilization by humans (agriculture, industrial, domestic, recreational, fisheries)
- K.6.Safe disposal of wastewater, human excreta, and solid waste
- K.7.Household sanitation and food hygiene
- K.8.Basic understanding of water science –hydrology, the hydrologic cycle, and connection to climate change

Skills and applications

- S.1.Understanding and conscious water consumption
- S.2.Understanding of water-related issues for behavioral changes
- S.3.Understanding of water scarcity and abundance
- S.4.Conceptualizing water flowing through landscape-scale systems
- S.5.Apply understanding of the structure of watershed to explain the movement of water and other substances
- S.6.Ability to interpret common representations, such as maps of waterways
- S.7.Safe handling of drinking water
- S.8.Understanding how water moves through environmental systems, interacts with other substances, dissolves, and moves certain substances underground

Values and attitudes

- V.1.Responsible and sustainable consumption
 - V.2. Motivation to change patterns of unsustainable consumption
 - V.3. Understand appropriate personal hygiene; washing hands, and brushing teeth. etc.
 - V.4.Safe use of toilets and urinals, including cleansing and washing
 - V.5.Responsible and sustainable consumption
 - V.7.Link collection and treatment of solid waste with overall health risks
 - V.8.Sensitized to the ways that water is borrowed from and returned to nature through human activities
 - V.9.Making informed decisions about water at an individual or societal level
 - V.10.Participate in community decisions about how to manage landfills
-

Table A1 (Continued). SDGs content analysis rubric for the selected four SDGs (Osman et al., 2017)

Goal 8-Decent work and economic growth

Knowledge and understanding

- K.1.Job classifications
- K.2.Jobs in the school, community, etc.
- K.3.People who care
- K.4.Why people work
- K.5.Work, employment, unemployment, self-employment, and enterprise
- K.6.Social enterprise
- K.7.The SDGs
- K.8.What it means to combat inequality

Skills and applications

- S.1.Explain the different kinds of jobs in other parts of the world
- S.2.Exploring solutions for inequality
- S.3.Access and opportunity for all
- S.4.Holding meetings, budgeting, making rules, and selling products through role play

Values and attitudes

- V.1.Appreciation of the multifaceted nature of the world/surroundings
 - V.2.Value/appreciate the resources and services available
 - V.3.Gratitude
 - V.4.Finding positive solutions
 - V.5.Learn to value the different forms of work including paid work, unpaid care work, voluntary work, and creative expression
-

Goal 15- Life on land

Knowledge and understanding

- K.1.Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact
- K.2.Understand the importance of biodiversity and threats to biodiversity, habitat loss; concept of endangered species

Skills and applications

- S.1.Ability to communicate the importance of terrestrial ecosystems
- S.2.Analyze impacts and risks associated with biodiversity loss and ecosystem degradation
- S.3.Beginning to apply systems thinking to understand ecosystem interdependencies (e.g. deforestation leads to habitat loss)

Values and attitudes

- V.1.Appreciation for the need to conserve biodiversity
 - V.2.Basic understanding of rights of other species, and valuing the interdependence of species
-

APPENDIX B

Table B1. Mapping content of the UAE 2022 elementary school science curriculum framework to SDG 4, 6, 8, and 15

| Grade | SDG | Knowledge & understanding (%) | Skills & application (%) | Values & attitudes (%) |
|-------|---------------------------------------|-------------------------------|--------------------------|------------------------|
| 1 | SDG 4-Quality education | 73.00% | 1.35% | 1.35% |
| | SDG 6-Clean water and sanitation | 1.35% | 0.00% | 0.00% |
| | SDG 8-Decent work and economic growth | 1.35% | 0.00% | 0.00% |
| | SDG 15-Life on land | 18.00% | 9.45% | 0.00% |
| 2 | SDG 4-Quality education | 1.11% | 64.43% | 0.00% |
| | SDG 6-Clean water and sanitation | 1.11% | 2.22% | 0.00% |
| | SDG 8-Decent work and economic growth | 2.22% | 0.00% | 1.11% |
| | SDG 15-Life on land | 5.56% | 18.88% | 0.00% |
| 3 | SDG 4-Quality education | 0.00% | 58.56% | 0.00% |
| | SDG 6-Clean water and sanitation | 1.42% | 5.70% | 2.84% |
| | SDG 8-Decent work and economic growth | 2.84% | 0.00% | 2.84% |
| | SDG 15-Life on land | 8.57% | 17.13% | 1.42% |
| 4 | SDG 4-Quality education | 0.00% | 90.00% | 0.00% |
| | SDG 6-Clean water and sanitation | 0.00% | 6.00% | 2.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 0.00% | 0.00% |
| | SDG 15-Life on land | 0.00% | 6.00% | 0.00% |

APPENDIX C

Table C1. SDGs versus corresponding clusters of learning competencies with learning outcomes in 2022 science curriculum for grades 1-4

| SDGs | Clusters of learning competencies/learning outcomes | | | |
|---------------------------------------|---|---|---|---|
| | Grade 1 | Grade 2 | Grade 3 | Grade 4 |
| SDG 4–Quality education | S1–Demonstrate appropriate schooling behaviors. S4–Learning to learn. S5–Critical and engaged approach toward learning | K3–Why learning is important in my life. S4–Learning to learn. S5–Critical and engaged approach toward learning | S4–Learning to learn. S5–Critical and engaged approach toward learning | S3–Make connections between our own lives and those of others throughout the world. S4–Learning to learn. S5–Critical and engaged approach toward learning |
| SDG 6–Clean water and sanitation | K8–Basic understanding of water science–hydrology, the hydrologic cycle, and connection to climate change | K8–Basic understanding of water science–hydrology, the hydrologic cycle, and connection to climate change S1–Understanding and conscious water consumption S8–Understanding how water moves through environmental systems, interacts with other substances, dissolves, and moves certain substances underground | K5–Water resources and utilization by humans (agriculture, industrial, domestic, recreational, fisheries) S6–Ability to interpret common representations, such as maps of waterways. S8–Understanding how water moves through environmental systems, interacts with other substances, dissolves, and moves certain substances underground. V6–Motivation to change patterns of unsustainable consumption. V8–Motivation to change patterns of unsustainable consumption | S3–Understanding of water scarcity and abundance. S4–Conceptualizing water flowing through landscape-scale systems. S8–Understanding how water moves through environmental systems, interacts with other substances, dissolves, and moves certain substances underground. V1–Responsible and sustainable consumption |
| SDG 8–Decent work and economic growth | K1–Job classifications | K2–Jobs in the school, community, etc. K4–Why people work. V4–Finding positive solutions | K2–Jobs in the school, community, etc. K4–Why people work. V4–Finding positive solutions | |
| SDG 15–Life on land | K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact K2–Understand the importance of biodiversity and threats to biodiversity, habitat loss, concept of endangered species. S1–Ability to communicate the importance of terrestrial ecosystems. S2–Analyze impacts and risks associated with biodiversity loss and ecosystem degradation. S3–Beginning to apply systems thinking to understand ecosystem interdependencies (e.g. deforestation leads to habitat loss) | K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact K2–Understand the importance of biodiversity and threats to biodiversity, habitat loss, concept of endangered species. S1–Ability to communicate the importance of terrestrial ecosystems. S2–Analyze impacts and risks associated with biodiversity loss and ecosystem degradation. S3–Beginning to apply systems thinking to understand ecosystem interdependencies (e.g. deforestation leads to habitat loss) | K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact S1–Ability to communicate the importance of terrestrial ecosystems. S2–Analyze impacts and risks associated with biodiversity loss and ecosystem degradation. S3–Beginning to apply systems thinking to understand ecosystem interdependencies (e.g., deforestation leads to habitat loss) V1–Appreciation for the need to conserve biodiversity | S1–Ability to communicate the importance of terrestrial ecosystems. S3–Beginning to apply systems to understand ecosystem interdependencies (e.g., deforestation leads to habitat loss) |

APPENDIX D

Table D1. UAE science curriculum: Distribution of the four SDGs across the three dimensions of SD

| Grade | SDG | Environment: Percentage of emphasis as reflected in learning outcomes | Economic: Percentage of emphasis as reflected in learning outcomes | Social: Percentage of emphasis as reflected in learning outcomes |
|-------|---------------------------------------|--|---|--|
| 1 | SDG 4-Quality education | 0.00% | 0.00% | 24.00% |
| | SDG 6-Clean water and sanitation | 1.35% | 0.00% | 0.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 1.35% | 0.00% |
| | SDG 15-Life on land | 5.40% | 0.00% | 0.00% |
| 2 | SDG 4-Quality education | 0.00% | 0.00% | 22.00% |
| | SDG 6-Clean water and sanitation | 1.11% | 0.00% | 0.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 1.11% | 0.00% |
| | SDG 15-Life on land | 5.00% | 0.00% | 0.00% |
| 3 | SDG 4-Quality education | 0.00% | 0.00% | 29.00% |
| | SDG 6-Clean water and sanitation | 2.00% | 0.00% | 0.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 2.00% | 0.00% |
| | SDG 15-Life on land | 5.40% | 0.00% | 0.00% |
| 4 | SDG 4-Quality education | 0.00% | 0.00% | 30.00% |
| | SDG 6-Clean water and sanitation | 2.00% | 6.00% | 2.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 0.00% | 0.00% |
| | SDG 15-Life on land | 2.00% | 0.00% | 0.00% |

APPENDIX E

Table E1. Mapping content of elementary school science textbooks to SDG 4, 6, 8, and 15

| Grade | SDG | Knowledge & understanding (%) | Skills & application (%) | Values & attitudes (%) |
|-------|---------------------------------------|-------------------------------|--------------------------|------------------------|
| 1 | SDG 4-Quality education | 0.00% | 48.00% | 0.00% |
| | SDG 6-Clean water and sanitation | 0.00% | 0.00% | 0.00% |
| | SDG 8-Decent work and economic growth | 5.00% | 5.96% | 2.54% |
| | SDG 15-Life on land | 33.00% | 5.22% | 2.24% |
| 2 | SDG 4-Quality education | 2.70% | 31.00% | 0.00% |
| | SDG 6-Clean water and sanitation | 0.00% | 3.28% | 0.00% |
| | SDG 8-Decent work and economic growth | 4.37% | 0.00% | 5.83% |
| | SDG 15-Life on land | 13.8% | 4.39% | 0.00% |
| 3 | SDG 4-Quality education | 0.00% | 58.56% | 0.00% |
| | SDG 6-Clean water and sanitation | 1.42% | 5.70% | 2.84% |
| | SDG 8-Decent work and economic growth | 2.84% | 0.00% | 2.84% |
| | SDG 15-Life on land | 8.57% | 17.13% | 1.42% |
| 4 | SDG 4-Quality education | 0.00% | 32.00% | 0.00% |
| | SDG 6-Clean water and sanitation | 0.00% | 3.00% | 2.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 0.00% | 8.76% |
| | SDG 15-Life on land | 9.39% | 11.39% | 0.00% |

APPENDIX F

Table F1. Distribution of activities related to the four SDGs according to the total number of activities in science textbooks of grades 1-4

| SDGs | Clusters of learning competencies/learning outcomes | | | |
|---|--|--|--|--|
| | Grade 1 | Grade 2 | Grade 3 | Grade 4 |
| SDG 4– Quality education | S3–Make connections between our own lives and those of others throughout the world S4–Learning to Learn S5–Critical and engaged approach toward learning | K4–What I want to be when I leave school. S3–Make connections between our own lives and those of others throughout the world. S4–Learning to learn. S5–Critical and engaged approach toward learning. | S2–Identify own learning needs for persona development. S4–Learning to learn. S5–Critical and engaged approach toward learning. | K4–What I want to be when I leave school. S1–Demonstrate appropriate schooling behaviors. S2–Identify own learning needs for personal development. S3–Make connections between our own lives and those of others throughout the world. S4–Learning to learn. S5–Critical and engaged approach toward learning. |
| SDG 6–Clean water and sanitation | Not applicable | S1–Understanding and conscious water consumption S4–Conceptualizing water flowing through landscape-scale systems. S5–Apply understanding of the structure of watershed to explain the movement of water and other substances. S6–Ability to interpret common representations, such as maps of waterways. S8–Understanding how water moves through environmental systems, interacts with other substances, dissolves, and moves certain substances underground. | S1–Understanding and Conscious water consumption S2–Understanding of water- related issues for behavioral changes. S4–Conceptualizing water flowing through landscape- scale systems. | V1–Value/appreciate the resources and services available. V2–Motivation to change patterns of unsustainable consumption. S4–Conceptualizing water flowing through landscape-scale systems. S5–Apply understanding of the structure of watershed to explain the movement of water and other substances. S6–Ability to interpret common representations, such as maps of waterways. S8–Understanding how water moves through environmental systems, interacts with other substances, dissolves, and moves certain substances underground. |
| SDG 8– Decent work and economic growth | K1–Job classifications K2–Jobs in the school, community, etc. K4–Why people work. S1–Explain the different kinds of jobs in other parts of the world. V4–Appreciation of the multifaceted nature of the world/surroundings V1–Appreciation of the multifaceted nature of the world/surroundings V2–Value/appreciate the resources and services available | K1–Job classifications K2–Jobs in the school, community, etc. K4–Why people work. V4–Finding positive solutions. | K1–Job classifications K2–Jobs in the school, community, etc. V4–Why people work. | K1–Job classifications K2–Jobs in the school, community, K3–People who care. K4–Why people work. V1–Appreciation of the multifaceted nature of the world/surroundings V2–Value/appreciate the resources and services available. V4–Finding positive solutions |

Table F1 (Continued). Distribution of activities related to the four SDGs according to the total number of activities in science textbooks of grades 1-4

| SDGs | Clusters of learning competencies/learning outcomes | | | |
|---------------------|---|---|--|--|
| | Grade 1 | Grade 2 | Grade 3 | Grade 4 |
| SDG 15–Life on land | <p>K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact</p> <p>K2–Understand the importance of biodiversity and threats to biodiversity, habitat loss, concept of endangered species.</p> <p>S1–Ability to communicate the importance of terrestrial ecosystems.</p> <p>S2–Analyze impacts and risks associated with biodiversity loss and ecosystem degradation.</p> <p>S3–Beginning to apply systems thinking to understand ecosystem interdependencies (e.g. deforestation leads to habitat loss)</p> <p>V2–Basic understanding of rights of other species and valuing the interdependence of species.</p> | <p>K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact</p> <p>K2–Understand the importance of biodiversity and threats to biodiversity, habitat loss, concept of endangered species.</p> <p>S2–Analyze impacts and risks associated with biodiversity loss and ecosystem degradation.</p> <p>S3–Beginning to apply systems thinking to understand ecosystem interdependencies (e.g. deforestation leads to habitat loss)</p> | <p>K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact</p> <p>K2–Understand the importance of biodiversity and threats to biodiversity, habitat loss, concept of endangered species.</p> <p>S1–Ability to communicate the importance of terrestrial ecosystems.</p> <p>S2–Analyze impacts and risks associated with biodiversity loss and ecosystem degradation.</p> <p>S3–Beginning to apply systems thinking to understand ecosystem interdependencies (e.g. deforestation leads to habitat loss)</p> | <p>K1–Basic understanding of forest ecosystems, freshwater ecosystems, ecosystem health, and consequences of human impact</p> <p>K2–Understand the importance of biodiversity and threats to biodiversity, habitat loss, concept of endangered species.</p> <p>V1–Appreciation for the need to conserve biodiversity.</p> <p>S1–Ability to communicate the importance of terrestrial ecosystems.</p> <p>S2–Analyze impacts and risks associated with biodiversity loss and ecosystem degradation.</p> <p>S3–Beginning to apply systems thinking to understand ecosystem interdependencies (e.g. deforestation leads to habitat loss)</p> |

APPENDIX G

Table G1. UAE science textbooks: Distribution of the four SDGs across the three dimensions of SD

| Grade | SDG | Environment: Percentage of emphasis as reflected in learning outcomes | Economic: Percentage of emphasis as reflected in learning outcomes | Social: Percentage of emphasis as reflected in learning outcomes |
|-------|---------------------------------------|--|---|--|
| 1 | SDG 4-Quality education | 0.00% | 0.00% | 24.00% |
| | SDG 6-Clean water and sanitation | 1.35% | 0.00% | 0.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 1.35% | 0.00% |
| | SDG 15-Life on land | 5.40% | 0.00% | 0.00% |
| 2 | SDG 4-Quality education | 0.00% | 0.00% | 22.00% |
| | SDG 6-Clean water and sanitation | 1.11% | 0.00% | 0.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 1.11% | 0.00% |
| | SDG 15-Life on land | 5.00% | 0.00% | 0.00% |
| 3 | SDG 4-Quality education | 0.00% | 0.00% | 29.00% |
| | SDG 6-Clean water and sanitation | 2.00% | 0.00% | 0.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 2.00% | 0.00% |
| | SDG 15-Life on land | 5.40% | 0.00% | 0.00% |
| 4 | SDG 4-Quality education | 0.00% | 0.00% | 30.00% |
| | SDG 6-Clean water and sanitation | 2.00% | 6.00% | 2.00% |
| | SDG 8-Decent work and economic growth | 0.00% | 0.00% | 24.00% |
| | SDG 15-Life on land | 1.35% | 0.00% | 0.00% |

APPENDIX H

Some Activities From Grade 1 Textbooks

The first and second images explain what an astronomer does followed by an 'inquiry activity' for students to understand the importance of studying about objects in outer space. The third and fourth images show an 'Inquiry activity' for students to understand about different plant parts.

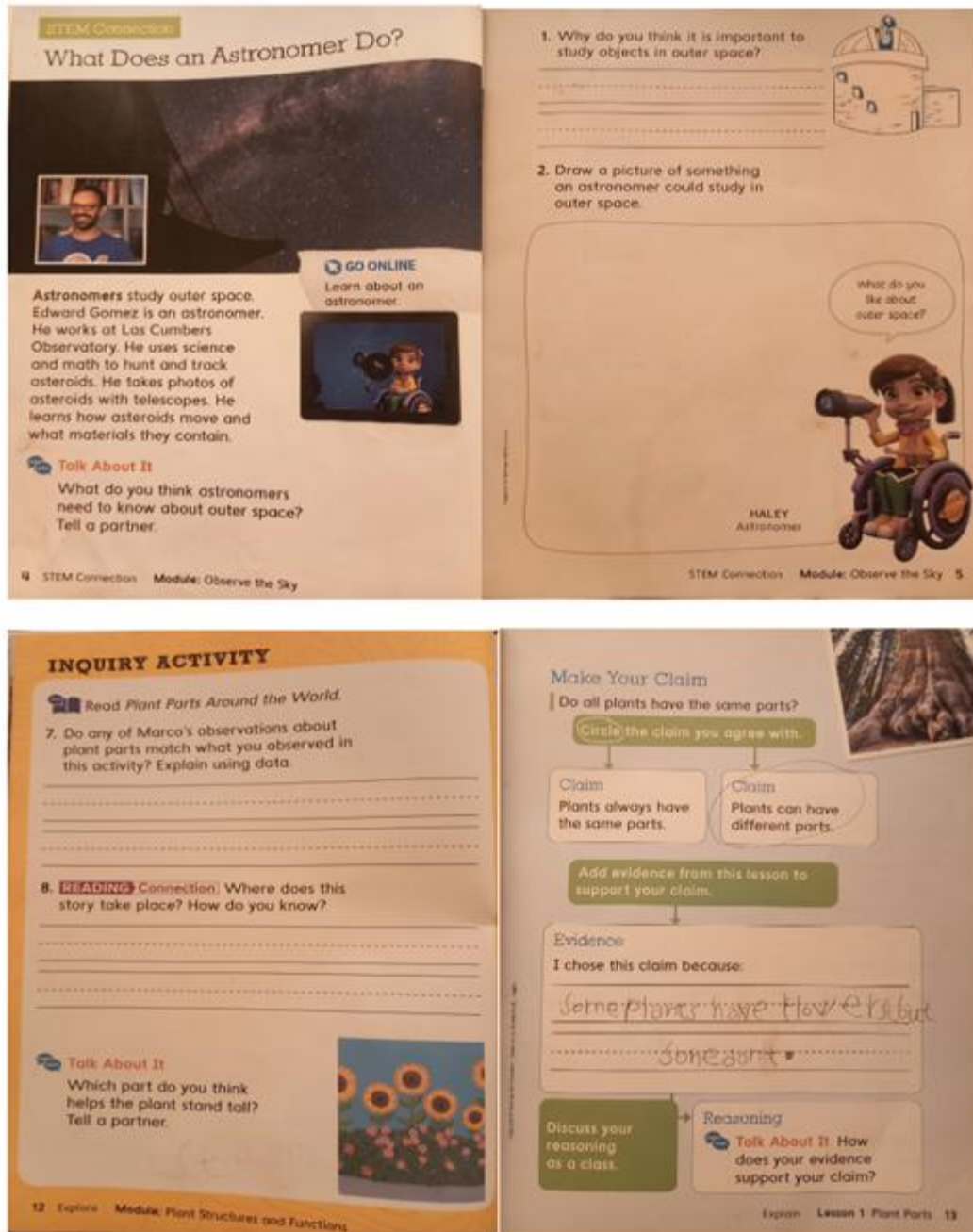


Figure H1. Image of the actual grade 1 science textbooks (Mc Graw-Hill Education)

Sample Activities From Grade 2 Textbooks

The first image depicts an 'inquiry activity' for students to understand about different 'bird beak shapes'. The second image explains about plant needs followed by an 'inquiry activity' as shown on images three and four for students to learn and understand about plant needs in different environments.

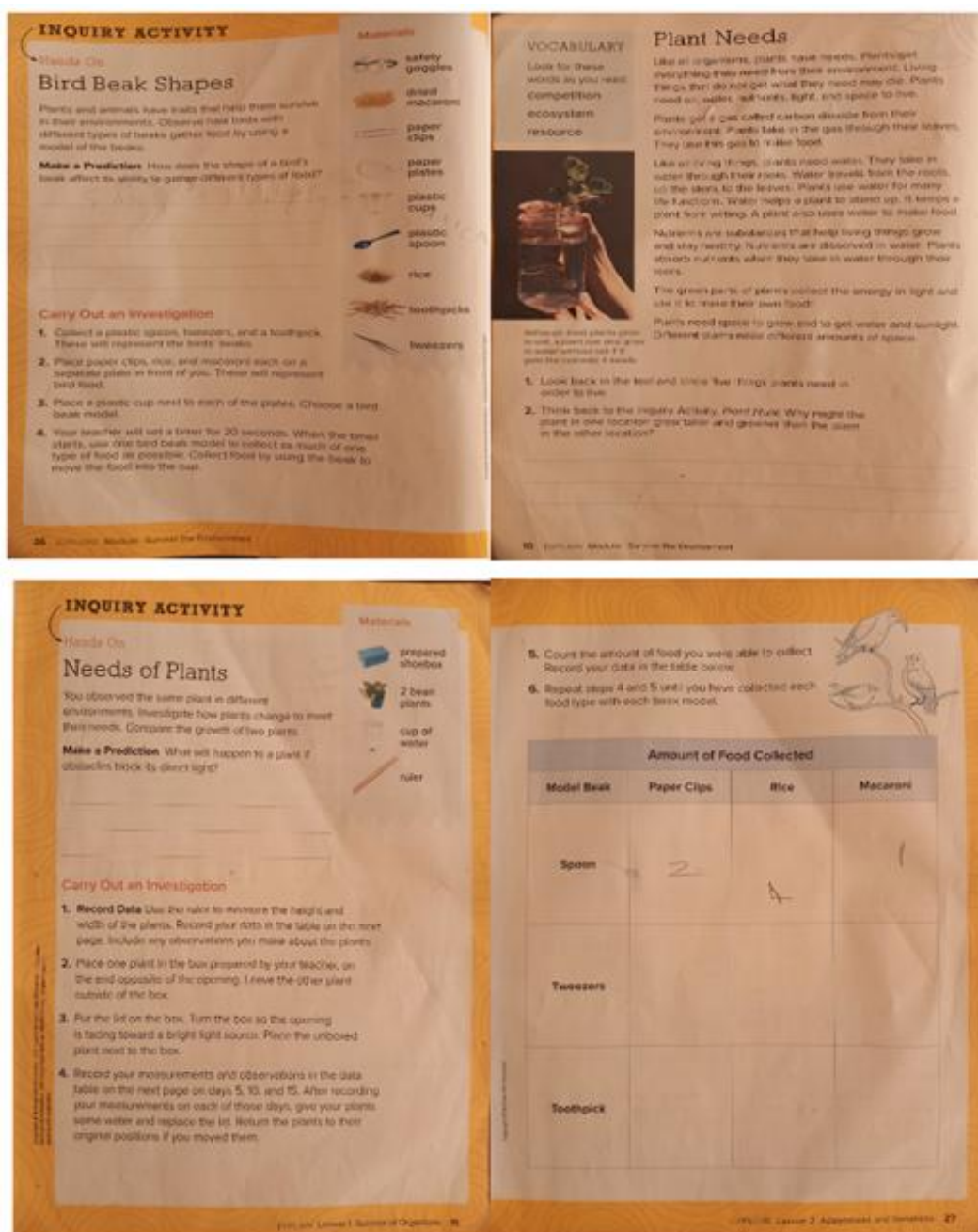


Figure H2. Image of the actual grade 2 science textbooks (Mc Graw-Hill Education)

Sample Activities From Grade 3 Textbooks

The first image depicts the explanation on ‘what does a broadcast meteorologist do?’ followed by an ‘inquiry activity’ shown on images two and three for students to imagine themselves as meteorologist and resolve a given scenario to present a weather forecast.



Figure H3. Image of the actual grade 3 science textbooks (Mc Graw-Hill Education)

Sample Activities From Grade 4 Textbooks

The first and second images explain earth's ocean features followed by an 'inquiry activity' as shown in images three and four for students to map the ocean floor and understand the topic thoroughly.

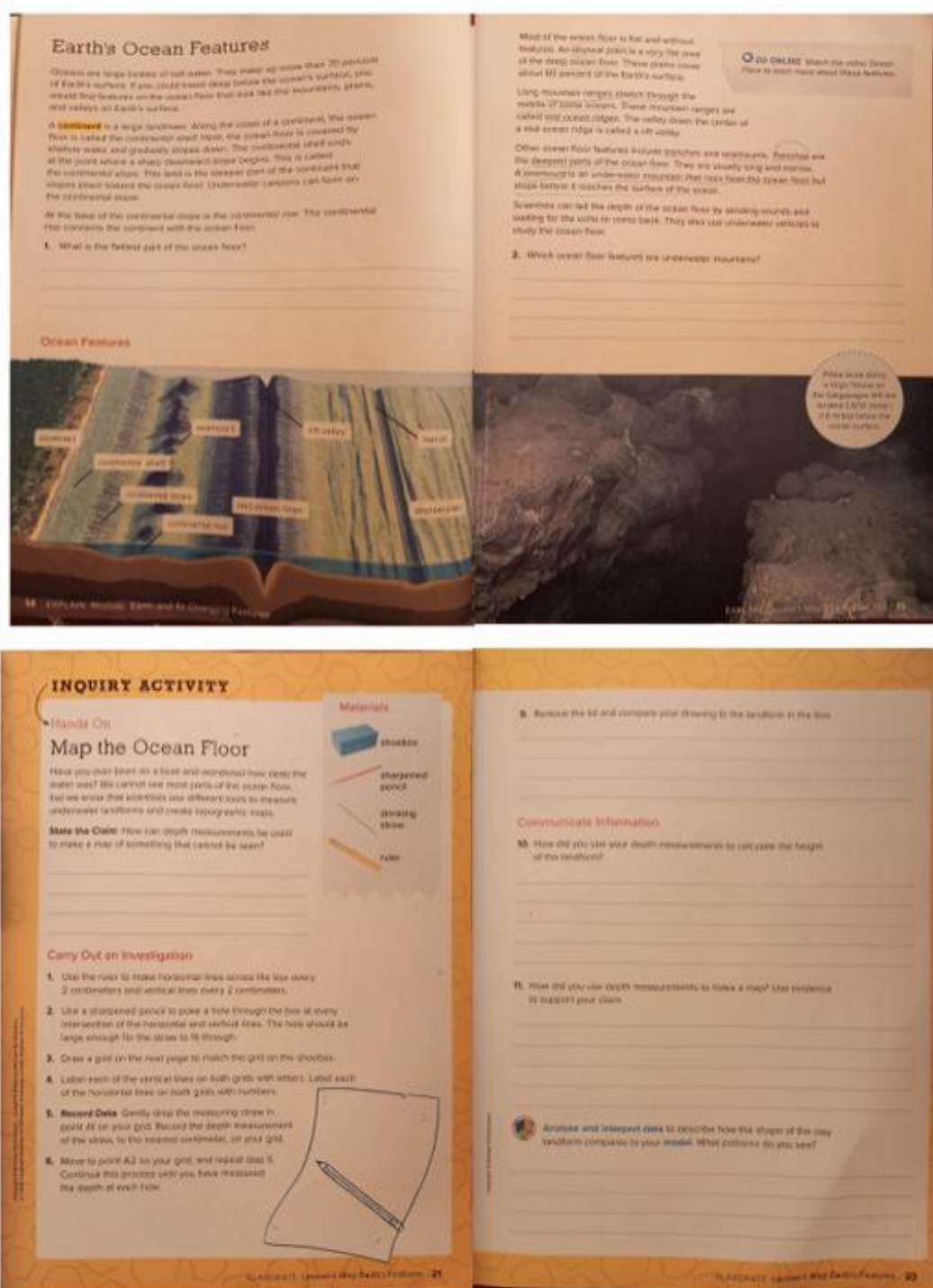


Figure H4. Image of the actual grade 4 science textbooks (Mc Graw-Hill Education)

<https://www.ejmste.com>