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Content Analysis of Science Curriculum for the Second Cycle of Elementary Education Based on Environmental Behavior Components in the Academic Year 2024-2025

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ABSTRACT

Objective: This study aimed to analyze the content of second-cycle elementary science textbooks (Grades 4, 5, and 6) with respect to components of environmental behavior during the 2024-2025 academic year.

Methods: The study employed a qualitative content analysis approach. The statistical population consisted of all fourth-, fifth-, and sixth-grade elementary science textbooks. The sample included three science textbooks, one from each grade, which were purposefully selected for analysis.

Results: The findings indicated that the components of education on green energy consumption and education on promoting environmental behavior received the highest level of emphasis, with an importance coefficient of 0.493. In contrast, components such as education on biodiversity conservation, positive interaction with nature, environmental responsibility, and environmental awareness and sensitivity received the lowest level of emphasis, with an importance coefficient of 0.000. These results suggest a stronger focus on renewable energy topics and practical environmental behaviors, particularly in the sixth-grade textbook. Additionally, in the fourth grade, the greatest emphasis was placed on education for sustainable resource consumption, while the least attention was given to green energy consumption and promotion of environmental behaviors.

Conclusions: Overall, the findings reveal an imbalance in the representation of environmental behavior components across elementary science textbooks, with greater emphasis on energy-related and practical behaviors and limited attention to ecological awareness and responsibility. Revising textbook content to provide a more comprehensive and balanced coverage of environmental behavior components is recommended to foster deeper environmental understanding and responsible attitudes among elementary school students.

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Introduction

In recent decades, the world has faced unprecedented environmental challenges, including climate change, biodiversity loss, pollution of water and soil resources, rising greenhouse gas emissions, and extensive degradation of natural resources. These challenges pose serious threats to the balance of ecosystems and to the quality of life of present and future generations. Such issues not only endanger human health and well-being but also jeopardize the sustainability of the planet as a whole (Klein, 2017). In this context, environmental education has gained increasing attention as a key strategy for promoting responsible and sustainable behaviors toward the environment, playing a crucial role in raising awareness and facilitating behavioral change aimed at environmental protection.

Environmental education is particularly significant at the primary school level, which represents a sensitive and formative period for the development of individuals' attitudes, values, and behaviors. During this stage, environmental education can have profound and long-lasting effects on students' environmental behaviors (Okada, 2017). Science curricula, as one of the main educational tools at this level, have the potential to guide students toward sustainable behaviors through the provision of appropriate content and hands-on activities (Ardoin, 2017). However, recent studies indicate that many primary science curricula in various countries, including Iran, tend to focus primarily on the transmission of theoretical knowledge while paying limited attention to affective components (such as positive environmental attitudes) and practical components (such as problem-solving and action-oriented skills) (Masha'ellahinejad, 2012).

Environmental education is recognized as one of the fundamental pillars for achieving the United Nations Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education) and Goal 13 (Climate Action). Numerous studies have demonstrated that effective environmental education should consist of a combination of three core components: the cognitive component (environmental knowledge), the affective component (attitudes and sense of responsibility), and the behavioral or practical component (applied and action-oriented skills) (Kollmuss, 2019). Together, these components can lead to sustainable behavioral change among students and foster the development of responsible citizenship (Stern, 2018).

Nevertheless, studies conducted in Iran reveal that primary school science textbooks—especially those used in grades four, five, and six (the second cycle of primary education)—largely emphasize

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theoretical knowledge, such as concepts related to ecosystems and natural processes, while giving less attention to the development of positive environmental attitudes, environmental sensitivity, and practical skills such as recycling, resource conservation, and environmental problem-solving (Masha'ellahinejad, 2012). This shortcoming is particularly concerning given that strengthening environmental behaviors during childhood can have deep and lasting impacts on individuals' future attitudes and actions, contributing to the mitigation of environmental problems at both national and global levels (Otto, 2017).

In the Iranian educational system, primary science textbooks are recognized as the main sources for teaching scientific and environmental concepts and play a significant role in shaping students' knowledge and behaviors (Mohammadi, 2013). These textbooks are not only responsible for conveying scientific knowledge but also have the potential to foster responsible environmental behaviors through the inclusion of practical activities, group projects, and the promotion of environmental values (Tilbury, 2017). Environmental education is a process through which individuals acquire the knowledge, skills, attitudes, and values necessary to make informed decisions and engage in environmentally responsible behaviors (Tilbury, 2017). This type of education extends beyond the mere transmission of scientific knowledge and emphasizes the cultivation of positive attitudes, a sense of responsibility, and practical skills for addressing environmental issues (Kaiser & Fuhrer, 2018).

According to researchers, environmental education is effective when it strengthens the relationship between environmental awareness, ethical values, and individuals' actual behaviors (Otto & Pensini, 2018). For instance, educational approaches that focus on fostering a sense of connectedness to nature and developing problem-solving skills can promote sustainable behaviors such as resource conservation, recycling, and participation in environmental protection activities (Evans & Block, 2019). This is especially important during childhood and adolescence, when fundamental values and behavioral patterns are formed (Chawla, 2017).

The primary school period—particularly the second cycle of primary education (grades four to six)—is considered one of the most critical stages for cultivating environmental behaviors. At this age, children possess a high level of cognitive and emotional readiness to understand environmental concepts, and the values formed during this period are likely to remain stable

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throughout their lives (Ernst, 2018). Therefore, school curricula, especially textbooks, play a key role in institutionalizing environmental behaviors (Hungerford, 2017). Science textbooks in the second cycle of primary education in Iran, due to their focus on scientific and natural concepts such as biological cycles, natural resources, and ecosystems, provide an appropriate platform for integrating environmental education. These textbooks not only convey scientific knowledge but can also shape students' attitudes, values, and practical skills related to environmental protection. A review of domestic and international studies related to this topic indicates that, to date, no comprehensive research has been conducted on the content analysis of primary school science textbooks in the second cycle of primary education based on components of environmental behavior. Existing studies have addressed relatively related topics, including those by Hosseini (2021), Liaghatirad (2021), Ahmadi (2023), Soltani (2023), Fathi (2020), Kaharazahi (2021), Kollmuss (2017), Bamberg (2017), Thøgersen (2017), French (2017), Bandura (2018), Hancock (2018), Wu (2018), Artuncio (2018), Carlson (2018), Gifford (2019), Kandi (2019), Steg (2019), Tilbury (2019), Wilson (2019), Wolf (2019), Chawla (2020), Clayton (2020), Hong (2020), and Kassir (2021). While these studies acknowledge the influence of science textbook content on environmental behavior components, no specific study has examined the content analysis of science textbooks in the second cycle of primary education (grades four, five, and six).

The significance and necessity of the present study lie in its potential to identify gaps in educational content and to propose recommendations for enriching curricula with practical activities. Such efforts can contribute to improving the quality of science education and fostering a generation that is environmentally aware and responsible. The importance of this research is further highlighted by its potential contribution to the improvement of Iran's educational system. Given the central role of teachers in curriculum implementation, the findings of this study can provide a foundation for teachers' professional development in integrating environmental behavior components into their instruction. Using educational guidelines derived from the study's findings, teachers can design classroom activities that encourage students' active participation in environmental issues. For example, activities such as visits to natural parks, school-based recycling projects, and the design of environmental awareness campaigns can strengthen sustainable behaviors among students.

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These measures not only enhance the quality of science education but also contribute to the development of an environmentally conscious and responsible generation, ultimately helping to reduce environmental challenges at the national level. Moreover, this study can support effective educational policymaking and the design of efficient curricula, thereby strengthening Iran's position in achieving global sustainability goals. Finally, this research can serve as a step toward filling the existing scientific gap in the analysis of primary school science textbooks from the perspective of environmental behaviors in Iran. Considering Iran's commitment to the Sustainable Development Goals and the need to educate environmentally responsible citizens, this study can contribute to effective educational policies and curriculum development. Additionally, in light of growing global awareness of the importance of environmental education, this research can align with international efforts in this field and strengthen Iran's role in advancing sustainability goals. The study may also serve as a model for other developing countries facing similar environmental challenges and facilitate global knowledge exchange. Accordingly, the main research question of this study is: To what extent are components of environmental behavior addressed in the content of science textbooks used in the second cycle of primary education?

Material and Methods

This study employed a content analysis method. Content analysis, as a research technique, encompasses systematic and specialized procedures for processing scientific data. Like other research techniques, its purpose is to generate understanding, provide new insights, depict reality, and offer guidance for action. In this study, the unit of analysis consisted of textbook pages, including written text, questions, exercises, and images. Primary school science textbooks comprise textual sections, illustrations, exercises, and questions; therefore, pages were selected as the unit of analysis to ensure comprehensive coverage of all content elements.

After identifying the measurement indicators, data collection and analysis were conducted using the Shannon Entropy model. Based on this model, the degree of attention given to each indicator in the primary school science textbooks for grades four, five, and six was determined. The results of this analysis are intended to provide useful insights for curriculum planners and textbook developers.

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The statistical population of the study included science textbooks for grades four, five, and six of primary education, published by the Ministry of Education in 2023 (1402 in the Iranian calendar). The primary education level was selected because, following the emphasis on foundational education, this stage marks the beginning of general education, prior to the introduction of specialized and university-oriented curricula at the secondary level. Consequently, it is expected that textbook content at this level places greater emphasis on comprehensive, holistic, and global education related to shared international issues.

The research sample consisted of three primary school science textbooks, with one science textbook selected from each of grades four, five, and six. Purposive sampling was employed in alignment with the research questions. Science textbooks were selected because they are expected to address contemporary global issues, including environmental concerns.

This study involved a quantitative content analysis of primary school science textbooks for grades four, five, and six, based on eight targeted components of environmental behavior. Ethical considerations were observed throughout all stages of data collection, analysis, and reporting of the findings.

Results

To examine the importance coefficient of each environmental behavior component, the data were first normalized using the Shannon Entropy method. The normalization was performed according to the following formula:

Table 1. Normalized Attention Data for Environmental Components in Primary School Science Textbooks (Second Cycle)

Textbook / Component	Sustainable Resource Use	Waste Management	Biodiversity Conservation	Positive Interaction with Nature	Environmental Responsibility	Environmental Awareness & Sensitivity	Green Energy Consumption	Promotion of Environmental Behavior
Grade 4 Science (128 pages)	0.267	0.286	0.333	0.333	0.333	0.333	0.000	0.000
Grade 5 Science (112 pages)	0.333	0.357	0.333	0.333	0.333	0.333	0.000	0.000
Grade 6 Science (112 pages)	0.400	0.357	0.333	0.333	0.333	0.333	1.000	1.000

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Interpretation: The normalized values indicate the relative distribution of attention to each component across grades. For example, "Green Energy Consumption" and "Promotion of Environmental Behavior" have zero values in grades four and five because attention to these components appears only in grade six. After normalization, the information entropy values of each component were calculated using the second-stage Shannon formula. The resulting values are presented in Table 2.

Table 2. Information Entropy Values for Attention to Environmental Components in Primary School Science Textbooks (Second Cycle)

Textbook / Component	Sustainable Resource Use	Waste Management	Biodiversity Conservation	Positive Interaction with Nature	Environmental Responsibility	Environmental Awareness & Sensitivity	Green Energy Consumption	Promotion of Environmental Behavior
Information Entropy	0.022	0.005	0.000	0.000	0.000	0.000	1.000	1.000

Interpretation: Entropy values represent the degree of uncertainty or the relative importance of each component. Values close to 1 (e.g., 1.000 for "Green Energy Consumption" and "Promotion of Environmental Behavior") indicate that attention is highly concentrated in one grade (grade six) and is not uniformly distributed. Values close to 0 (e.g., 0.000 for uniformly distributed components) reflect equal distribution across the three grades. To avoid calculation errors due to zero values in PijP_{ij}Pij, a very small number (0.00001) was substituted. The index jjj denotes the importance of each component within a specific message, and using the weight vector www, components are ranked accordingly.

Finally, the importance coefficient of each environmental component was calculated using the Shannon entropy-based formula. The results are shown in Table 3.

Table 3. Importance Coefficient of Attention to Environmental Components in Primary School Science Textbooks (Second Cycle)

Textbook / Component	Sustainable Resource Use	Waste Management	Biodiversity Conservation	Positive Interaction with Nature	Environmental Responsibility	Environmental Awareness & Sensitivity	Green Energy Consumption	Promotion of Environmental Behavior
Importance Coefficient	0.011	0.002	0.000	0.000	0.000	0.000	0.493	0.493

Interpretation: The importance coefficient reflects the relative weight of each component within the overall system. "Green Energy Consumption" and "Promotion of Environmental Behavior"

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have the highest importance (0.493) because attention to these components is concentrated in grade six and not evenly distributed. Components such as "Biodiversity Conservation," "Positive Interaction with Nature," "Environmental Responsibility," and "Environmental Awareness & Sensitivity" have the lowest importance (0.000) due to their uniform distribution across the three grades.

The results indicate that, in second-cycle primary school science textbooks: The most attention is given to Sustainable Resource Use, the least attention is given to Green Energy Consumption and Promotion of Environmental Behavior, concentrated mainly in grade six and some indicators, such as "Caring for Nature" (under Positive Interaction with Nature) and "Understanding Environmental Harm" (under Environmental Awareness & Sensitivity), are largely neglected.

Overall, the attention hierarchy in these textbooks is as follows: Sustainable Resource Use > Waste Management > Biodiversity Conservation > Environmental Responsibility > Environmental Awareness & Sensitivity > Positive Interaction with Nature > Green Energy Consumption = Promotion of Environmental Behavior. This pattern indicates that while textbooks emphasize sustainable resource use, other critical environmental behavior components—particularly practical and action-oriented behaviors—receive limited focus, especially in the lower grades.

Discussion

The present study aimed to analyze the content of second-cycle primary school science curricula based on environmental behavior components. The results indicated that the components of “Green Energy Consumption Education” and “Promotion of Environmental Behavior” received the highest importance coefficients (0.493), whereas components such as Biodiversity Conservation Education, Positive Interaction with Nature, Environmental Responsibility, and Environmental Awareness and Sensitivity received the lowest importance coefficients (0.000). This pattern reflects a stronger focus on renewable energy and practical behavior-related content, particularly in grade six. Overall, the findings show that primary science textbooks pay the greatest attention to Sustainable Resource Use Education, while Green Energy Consumption and Promotion of Environmental Behavior receive the least attention.

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These findings align with previous studies (Hosseini, 2021; Liaghatirad, 2021; Ahmadi, 2023; Soltani, 2023; Fathi, 2020; Kaharazahi, 2021; Kollmuss, 2017; Bamberg, 2017; Thøgersen, 2017; French, 2017; Bandura, 2018; Hancock, 2018; Wu, 2018; Artuncio, 2018; Carlson, 2018; Gifford, 2019; Kandi, 2019; Steg, 2019; Tilbury, 2019; Wilson, 2019; Wolf, 2019; Chawla, 2020; Clayton, 2020; Hong, 2020; Kassir, 2021).

Analysis of the results shows that the dominant approach in textbook content emphasizes tangible and everyday practices, such as water conservation, optimal resource use, and waste separation. The greater focus on Sustainable Resource Use and Waste Management can be attributed to the concreteness of these concepts and the relative ease of teaching them to primary school students. These components are directly linked to students' daily lives and are therefore more frequently represented in examples, illustrations, and learning activities within the textbooks. However, the excessive focus on these two components has led to less attention to other critical dimensions of environmental behavior, particularly those that require attitudinal change and behavioral modification.

The findings also indicate that components such as Biodiversity Conservation, Positive Interaction with Nature, and Environmental Responsibility are present only to a moderate extent and primarily in descriptive form within textbook content. These components are often limited to the introduction of concepts and the discussion of their importance, with minimal engagement in practical activities, field experiences, or decision-making scenarios for students. Consequently, while initial awareness is raised, opportunities to internalize environmental responsibility are limited.

Moreover, the lack of emphasis on Green Energy Consumption and Promotion of Environmental Behavior highlights a fundamental gap in the curriculum. Given that clean energy and sustainable consumption are among the most pressing environmental challenges globally, insufficient content in these areas may reduce opportunities to educate a future generation equipped to address these issues. Similarly, the limited promotion of environmental behavior suggests that the curriculum prioritizes knowledge acquisition over action and practice.

The results demonstrate that the second-cycle primary school science curricula are imbalanced in addressing environmental behavior components. Although components such as Sustainable

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Resource Use and Waste Management receive relatively satisfactory attention, key components such as Green Energy Consumption and Promotion of Environmental Behavior are minimally represented. This indicates a cognitive and informational approach dominates over an attitudinal and behavioral approach in environmental education. Therefore, it can be concluded that, while current science textbooks raise environmental awareness among students, they do not sufficiently foster sustainable and responsible environmental behaviors. Effective environmental education requires simultaneous attention to knowledge, attitudes, skills, and action, which is not fully achieved in the existing content.

Based on these findings, it can be concluded that, although second-cycle science curricula are relatively acceptable in terms of providing environmental knowledge, they face serious challenges in comprehensively cultivating environmental behavior. The dominance of a cognitive approach over attitudinal and behavioral approaches keeps environmental education primarily at the awareness level and limits its ability to generate sustainable behavioral change. The imbalance among components—particularly the neglect of Green Energy Consumption and Promotion of Environmental Behavior—underscores the need for a substantive revision of curriculum content.

Environmental education in primary schools should be designed to ensure that students not only acquire environmental concepts but also develop the ability to make responsible decisions, participate actively, and act consciously in environmental matters. Accordingly, it can be concluded that second-cycle science curricula, despite their potential to educate students about the environment, have not effectively promoted comprehensive environmental behavior. The predominance of cognitive content over attitudinal and behavioral content hinders the achievement of the fundamental goals of environmental education, namely, cultivating responsible, engaged, and committed citizens.

Finally, the results of this study highlight the necessity of a purposeful revision of science curriculum content. Designing curricula that simultaneously address knowledge, attitudes, skills, and actions and incorporate all environmental behavior components—particularly Green Energy Consumption and Promotion of Environmental Behavior—in a balanced and practical manner can play a critical role in institutionalizing sustainable environmental behaviors from the primary level, laying the foundation for sustainable development in society.

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It is recommended that, in revising primary school science curricula, a comprehensive and behavior-oriented approach be adopted, giving special attention to components such as clean energy consumption, active student participation in environmental activities, and practicing responsible behaviors. Such an approach can effectively contribute to the education of a generation that is aware, sensitive, and committed to the environment. Curriculum planners and textbook authors should adopt a balanced, practical, and integrative approach to include all environmental behavior components. Additionally, the use of active and integrated teaching methods, along with teacher training and empowerment in environmental education, can foster responsible environmental attitudes and behaviors among students, preparing a generation capable of achieving sustainable development goals in the future.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by ethics committee of Islamic Azad University.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection and analysis. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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