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A Comparative Investigation of Environmental Literacy Dimensions in Science Curricula of Several Countries

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Environmental education is necessary to prevent environmental problems. It is useful to analyze the curricula in order to understand the importance given to environmental education. In this study, it was aimed to examine the learning outcomes in Türkiye, Canada (Ontario), Australia, USA (Massachusetts) and England primary science curricula in terms of environmental education and to analyze and compare them according to the dimensions of environmental literacy which are formed knowledge, cognitive skills, affect and behavior. This study was a qualitative study, and the data were collected through document analysis and analyzed through content analysis. In the comparisons made according to the number of environmental outcomes, it was observed that the highest number of outcomes was present in the curriculum of Canada, while the lowest number of outcomes was present in the curriculum of England. All dimensions were found in all curricula except the Science and Technology Curriculum in England, but not all dimensions were equally included in the curricula. In England's curriculum, had no outcomes related to the behavior dimension. The common result was that in all of the curricula, the outcomes in the cognitive skills dimension are more common, while the outcomes in the affective and behavioral dimensions are more limited.

Introduction

There is an existing balance in natural systems. However, this natural balance is disrupted unless mutual interactions continue in the environment, which is an environment consisting of living and non-living factors (Bozkurt & Cansüngü Koray, 2002). The ordinary actions of many of us in our daily lives affect our environment and cause problems, even if we do not realize it. Our environment, which we affect with our unconscious actions, has a very important place for us because we obtain the materials necessary for our basic needs from our environment (Roth, 1968). The sustainability of the environment is the responsibility of people. The negative consequences of people's individual and collective

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activities on the environment make countries need to take collective action (UNESCO, 1978). In order to prevent environmental problems, people need to change their negative thoughts and behaviors towards the environment. It is only possible for individuals to change their behaviors towards the environment by changing their current attitudes, environmental knowledge and values. For this, environmental education is necessary (Erten, 2005). To solve these problems, it is essential to have individuals who can understand the basis of the problems and produce useful solutions. This is possible by raising individuals with environmental literacy (Hollweg, Taylor, Bybee, Marcinkowski, McBeth, & Zoido, 2011).

The concept of environmental education was first used at the International Union for Conservation of Nature and Natural Resources Conference (IUCN) in Paris in 1948 (Palmer, 1998). 1972 was a very important year for environmental education in the international arena (Carter & Simmons, 2010). Environmental problems were discussed globally for the first time at the "UN Conference on Environment and Human Beings" in Stockholm in 1972 (Kışoğlu, Gürbüz, Sülün, Alaş, & Erkol, 2010). In 1975, the International Environmental Education Program (IEEP) was launched in partnership with UNESCO and UNEP (Güler, 2013). In the same year, it was declared in the Belgrade Charter that a global environmental education program should be established to contribute to the acquisition of knowledge, skills, attitudes and value judgments that will enable individuals to achieve a better environment and quality of life. In the 1975 Belgrade Charter, some goals for environmental education were mentioned. The aim is to raise individuals who are aware of environmental problems, care about these problems and have the knowledge, skills and attitudes that will enable them to take personal and social actions for their solution (UNESCO, 1978).

The definitive recognition of environmental education at the international level dates back to the first "Intergovernmental Conference on Environmental Education" held in Tbilisi in 1977 (Carter & Simmons, 2010). In this conference, organized for the first time between October 14-26, 1977, by UNESCO in cooperation with UNEP, the main points of the conference were the leading environmental problems of societies, the contribution of education in combating these problems, national and international contributions to environmental education, and cooperation (UNESCO, 1978). "Our Common Future" published by the UN World Commission on Environment and Development in 1987 attracted attention in almost all countries (Baykal & Baykal, 2008). At the conference organized by UNESCO and the Greek government in Thessaloniki in 1997, environmental education's main goal was raising environmentally literate individuals who are responsible for the environment and can produce solutions to environmental problems that may arise in the 21st century (Knapp, 2000).

Environmental literacy was originally described by Roth (1968) as the degree to which people are aware of and knowledgeable about their surroundings. Roth (1992) defined environmental literacy is the capacity to understand and assess whether environmental systems are operating as intended and to take the appropriate steps to ensure the systems' development, sustainability, and repair. As stated by Morrone, Mancl, and Carr (2001), environmental literacy is the capacity to integrate ecological information with moral judgments such that it may be applied to conduct. If people's environmental knowledge is not translated into ecologically conscious actions, it is incorrect to refer to them as environmentally literate (Morrone, Mancl, & Carr, 2001). According to Roth (1992), the knowledge dimension encompasses both ecological knowledge and the ability to define environmental terms and to know the interaction between environmental phenomena and natural systems. Affect, on the other hand, is the level of sensitivity towards the environment and environmental problems and the level of attention to ethical and moral elements in environmental behaviors. The

cognitive skill dimension of environmental literacy is the ability to use environmental knowledge and values to solve environmental problems. Finally, the behavior dimension is the ability to take positive actions towards the environment as an indicator of knowledge, cognitive skills and value judgments. In the literature, the most preferred dimensions of environmental literacy are those defined by Roth (1992) (Kışoğlu et al., 2010).

The development of environmental literacy should be one of the main objectives of the programs implemented in schools, which are part of the education system (Roth, 1992). Hungerford and Peyton (1986), in their study, aimed to prepare a curriculum for secondary schools for environmental education. These objectives generally include ecological foundations and awareness, skills for investigating and evaluating environmental problems, and active participation. The goals established by Hungerford, Peyton and Wilke (1980) are seen as a framework for curriculum development in many national and international documents (Hungerford & Peyton, 1986).

To support a more sustainable future, science curricula and textbooks now incorporate both existing and emerging environmental problems, along with potential solutions, in order to enhance students' environmental awareness. These issues are presented in a way that enables learners to understand the significance of environmental challenges and the impact of human activity on the natural world. Sustainable development and its associated impacts are fundamental topics within the environmental domain. Consequently, when designing curricula or textbooks, it is essential to approach the concept of the environment from a comprehensive and multifaceted perspective. Science curricula and textbooks that integrate environmental literacy can serve as valuable tools for both protecting the natural environment and promoting its sustainable use. Moreover, these educational resources offer opportunities for individuals to not only understand concepts related to the natural environment but also to apply them in real-world contexts. Therefore, well-designed science curricula and textbooks play a critical role in advancing environmental literacy and fostering a deeper understanding of ecological sustainability (Kaya & Elster, 2019).

Comparing the learning outcomes across different curricula provides valuable insights for educators and policymakers. For instance, a study conducted by Fytopoulou et al. (2023) found that students who took environment-related courses exhibited more positive environmental attitudes. Such comparisons help identify which curricula are more effective in fostering environmental literacy and contribute to the enhancement of educational programs (Fytopoulou, Karasmanaki, Tampakis, & Tsantopoulos, 2023).

In literature, comparing learning outcomes across curricula is important for testing educational theories and pedagogical approaches. For instance, Akçay (2024) compared the Turkish and English science curricula in terms of environmental education, analyzing the environmental objectives and content of both programs. Such comparisons contribute to understanding the impact of different educational systems on environmental education and play a role in shaping educational policies. In this study, since raising environmentally literate individuals is very important for the sustainability of the environment and environmental education and therefore curricula play an important role in this process, the science curricula of different countries were comparatively examined in terms of the extent to which they include the dimensions of environmental literacy, namely knowledge, cognitive skills, affect, and behavior, across various levels and learning areas. While various curricula from different countries have been explored within the framework of environmental education in the existing literature, no comprehensive and contemporary study has been identified that addresses all

dimensions of environmental literacy. Therefore, this study aims to contribute to the body of knowledge by elucidating the current state of the field (Eken, 2010; Özata Yücel & Özkan, 2013; Ürey & Aydın, 2014; Yolcu, 2014; Derman, 2015; Bekdaş, 2019; Barak & Gönençgil, 2020; Erten vd. 2022; Fidan Yazgan, 2023).

Literature Review

Examining the studies in the literature, it is clear that few of them inquire into the extent to which the curriculum targets the knowledge, skills, attitudes, and behavior that make up environmental literacy and are critical elements in averting environmental problems. Environmentally oriented achievements were the general criteria used to evaluate the accomplishments in the curricula (Eken, 2010; Özata Yücel & Özkan, 2013; Ürey & Aydın, 2014; Yolcu, 2014; Derman, 2015; Bekdaş, 2019). Environmental education places a strong emphasis on encouraging environmentally conscious behavior. Because of this, it is crucial to evaluate the curricula while taking into account every aspect to identify the current state of affairs.

In general, life science, science curricula and textbooks have been examined in terms of environmental education, but there are not many studies on the dimensions of environmental literacy (Eken, 2010; Özata Yücel & Özkan, 2013; Ürey & Aydın, 2014; Yolcu, 2014; Derman, 2015; Bekdaş, 2019; Barak & Gönençgil, 2020; Erten vd. 2022; Fidan Yazgan, 2023). In various studies comparing the 2005 science curriculum with the curricula in countries such as Canada, the USA, Australia, Ireland, Singapore, it has been stated that the curriculum in Türkiye is incomplete and limited in terms of environmental education, while Canada's curriculum is richer and exemplary. In general, it was concluded that the curricula were insufficient in affective areas (Özata Yücel, 2008; Cebesoy & Dönmez Şahin, 2010; Derman, 2015; Erten vd. 2022; Kılıç, 2022). In the studies comparing the 2005-2013-2018 curricula in Türkiye in terms of environmental objectives, it was seen that the number of objectives and course hours were reduced as the programs changed (Özata Yücel & Özkan, 2013; Bekdaş, 2019). A review of the literature shows that there are very few studies examining the extent to which the components of environmental literacy, such as knowledge, skills, affect, and behavior, which are important in preventing environmental problems, are addressed in educational curricula. Most of the existing studies have analyzed the learning outcomes in the curricula in terms of their relevance to environmental issues (Eken, 2010; Özata Yücel and Özkan, 2013; Ürey and Aydın, 2014; Yolcu, 2014; Derman, 2015; Bekdaş, 2019). Developing responsible behaviors toward the environment holds a significant place in environmental education. Therefore, examining curricula with a focus on all components of environmental literacy is crucial for identifying the current state.

Method

Research Design

In this study, qualitative research method was used because it was aimed to analyze the 2018 Elementary Science (3rd-8th grade), 2022 Canada-Ontario Science and Technology (1st-8th grade), 2018 Australian Science (F-10), 2016 US Massachusetts State Science and Technology/Engineering (1st-8th grade) and UK 2015 Science curricula according to the dimensions of environmental literacy and to reveal their current status. International assessments such as PISA and TIMSS evaluate students' academic performance both within and across countries and help assess how effectively national science curricula meet

educational goals (Brown & Brown, 2007; EARGED, 2003). According to PISA 2018 results, science rankings among OECD countries placed Canada 5th, the United Kingdom 9th, Australia 12th, the United States 13th, and Turkey 30th (OECD, 2019). In the 2022 results, Canada ranked 4th, Australia 6th, the United Kingdom 11th, the United States 12th, and Turkey 29th (OECD, 2023). Given the consistently strong performance of these countries in science, their curricula were selected for comparison with Turkey's current science curriculum. Country selection was based on both high achievement in international exams and representation from different geographic regions. Additionally, to facilitate the comparison, only countries where English is the language of instruction were included.

Qualitative research method is a research method that enables realistic and holistic disclosure of events and phenomena in their current environment and collects data through methods such as observation, interview and document analysis (Yıldırım & Şimşek, 2018).

The research also utilized the horizontal approach, which is a comparative education approach. The horizontal approach is a research approach in which the education systems of different countries and the different elements of the curricula used within the systems are examined individually but in parallel as a whole. In this approach, the variables involved in the research are brought side by side and existing differences are revealed (Aynal, 2012).

Data Collection and Analysis

In the study, data were collected through document analysis. According to Yıldırım and Şimşek (2018), document analysis is the analysis of written or visual materials containing information about the subject that the researcher wants to examine. This study aims to evaluate the inclusion of environmental literacy dimensions in primary school science curricula in Turkey, Canada (Ontario), Australia, the United States (Massachusetts), and the United Kingdom. For this purpose, the 2018 National Science Curriculum from Turkey's Ministry of National Education, the 2022 Science Curriculum from Ontario's Ministry of Education, the 2018 Science Curriculum from the Australian Curriculum, Assessment and Reporting Authority (ACARA), the 2016 Science Curriculum from the Massachusetts Department of Elementary and Secondary Education (DOE), and the 2015 National Science Curriculum from the UK Department for Education were accessed.

All the curricula used in the study are original documents published online and publicly available on the official websites of the respective countries' Ministries of Education/Departments of Education. Therefore, the documents were confirmed to be original.

Firstly, the researcher examined the elementary science curricula of the countries identified in the study. Environmental objectives were identified, and analyses were conducted according to research problems and sub-problems. In order to compare the 2018 Turkish Elementary Science Curriculum with curricula from different countries in terms of environmental literacy, all the curricula published in English (Canada-Ontario, USA-Massachusetts, Australia, and the UK) were translated into Turkish by the researcher. The achievements presented in the curricula were thoroughly examined by the researcher. Relevant literature and books were reviewed to identify concepts and content related to the environment, so that environmental achievements could be selected from the curricula. Then, depending on the purpose of the study, environmental objectives, sub-objectives and explanations were examined, coding and categorization were made. The existing objectives were examined by two more experts from the fields of environment, science education, measurement and evaluation, and their opinions

were obtained. Particular attention was paid to ensuring that one of the experts consulted was a faculty member specialized in environmental education who teaches undergraduate and graduate courses in the field. This expert provided feedback on the appropriateness of the selected environmental learning outcomes from the curricula and the validity of their alignment with the dimensions of environmental literacy. In selecting the second expert, care was taken to choose a faculty member with specific expertise in assessment and evaluation in science education. This expert was consulted particularly to evaluate the taxonomic alignment of the selected environmental learning outcomes within the curricula.

Content analysis was used to analyze the data obtained in the study. A conceptual framework for the dimensions of environmental literacy exists in the literature. While some of the codes for the data were developed based on existing literature, they were further expanded through a detailed examination of the learning outcomes in the curricula. Given the presence of an existing theoretical framework, the categories of the study were identified following a comprehensive review of the literature related to the research problem. Sub-categories were then developed by identifying similarities and differences among the derived codes and grouping related ones together. To ensure that the identified categories adequately represented the data set and that the code- category matches were accurate, expert opinions were consulted. After coding the selected outcomes in accordance with the scope of the research and associating them with the dimensions of environmental literacy, the data obtained from the curricula of each country were quantified separately according to grade levels and learning areas and tables were created. Then, the data obtained from all programs were combined in a table and the findings of the countries were compared.

The dimensions of environmental literacy are considered as knowledge, cognitive skills, affect and behavior. While developing the categories, the Tbilisi Declaration (1978), Roth (1992), Hsu (1997), Simmons (1995) and Roth (1992)'s “Knowledge”, “Cognitive Skills”, “Affect” and “Behavior” categories were taken as the dimensions of environmental literacy. As the learning outcomes related to the knowledge dimension reflect the subcognition according to Bloom’s taxonomy, the knowledge and cognitive skills dimensions were merged in this study, and the categories of subcognition and metacognition were established under the cognitive skills dimension. While the objectives related to the knowledge dimension were evaluated as subcognition under the cognitive skill dimension, the objectives expressing the cognitive skill dimension such as analysis, synthesis of information and evaluation of solution proposals for solving environmental problems were evaluated in the metacognition category under the cognitive skill dimension. While attitudes toward the environment and environmental problems were evaluated as the affective dimension, performing positive actions was evaluated as the behavioral dimension.

In this study, particular attention was paid to ensuring validity and reliability throughout the research process. According to Kirk and Miller (1986), validity refers to objectively and accurately representing the phenomenon being studied. Accordingly, consistency was maintained during data collection, analysis, and interpretation, and all steps were clearly described. The selected countries’ science curricula were translated from English to Turkish and analyzed in depth. To determine whether each learning outcome was related to the environment, a list of environmental concepts was created based on the literature, and all outcomes were examined conceptually. The grouping of outcomes according to environmental literacy dimensions followed a similar process, using definitions derived from literature. Each curriculum was analyzed individually and then compared. These procedures were repeated multiple times by the researcher to ensure internal validity, and expert opinions

were obtained for confirmation.

To ensure external validity, data collection and analysis steps were described in detail. For the core objective of the study—categorizing outcomes according to environmental literacy dimensions—a level was selected from each country's curriculum. Direct excerpts were used to create tables showing how outcomes were matched with literacy dimensions, which were included under the findings section. Regarding reliability, the study followed the principles of consistency and confirmability. The research process, including data selection and analysis, was documented in a transparent and detailed manner to support reproducibility.

For internal reliability, findings were supported with direct quotations, and expert opinions were sought. Contributions from two experts in science education, environmental education, and assessment helped increase the study's trustworthiness. In addition, coding and categorization were assessed using Miles and Huberman's (1994) reliability formula. Agreement and disagreement among coders were evaluated, and the reliability percentage was calculated to be above the recommended 80% threshold.

Reliability Formula= (Agreement/Agreement + Disagreement) x 100

In order to ensure the validity of the study, the acquisitions determined by the researcher and the acquisitions on which there was a difference of opinion in the light of the data obtained with expert opinions were discussed again. As a result of the calculation, the reliability was 91.2%.

Ethics Statements

The document regarding the exemption form of Hacettepe University Institute of Educational Sciences Ethics Committee for the research and its English translation are attached.

Findings

In this study, the dimensions of environmental literacy were considered as "Knowledge, Cognitive Skills, Affect and Behavior". However, since it was thought that it would be more appropriate to include the objectives related to the "Knowledge" dimension under the "Cognitive Skill" dimension and to evaluate them as subcognition according to Bloom's taxonomy under the "Cognitive Skill" dimension, the titles "Cognitive Skill, Affect and Behavior" were included in the tables.

Table 1 was created to illustrate how the learning outcomes were structured according to the dimensions of environmental literacy.

Table 1. Analysis of 3rd grade environmental learning outcomes in the Turkish science curriculum according to the dimensions of environmental literacy

Learning Area	Unit	Objectives	Dimensions of Environmental Literacy		
			Cognitive Skills	*Affect*	*Behavior*
Earth and Universe	Let's Get to Know Our Planet	F.3.1.2.1. Recognizes that the Earth's surface consists of land and water.	X		
		F.3.1.2.2. Explains that there is a layer of air surrounding the Earth.	X		
		F.3.1.2.3. Compares the areas covered by land and water on the Earth's surface using a model.	X		
Physical Phenomena	Light and Sounds Around Us	F.3.5.2.1. Classifies light sources in the environment as natural and artificial.	X		
		F.3.5.3.3. Classifies sound sources in the environment as natural and artificial.	X		
Living Beings and Life	A Journey to the World of Living Beings	F.3.6.1.1. Classifies living and non-living things using examples from the environment.	X		
		F.3.6.1.2. Presents observation results related to the life cycle of a plant.	X		
		F.3.6.2.1. Recognizes the environment in which they live.	X		
		F.3.6.2.2. Actively participates in maintaining the cleanliness of their environment.			X
		F.3.6.2.3. Explains the differences between natural and artificial environments.	X		
		F.3.6.2.4. Designs an artificial environment.	X		
		F.3.6.2.5. Recognizes the importance of the natural environment for living beings.		X	
		F.3.6.2.6. Conducts research and proposes solutions to protect the natural environment.	X		
Physical Phenomena	Electric Vehicles	F.3.7.2.2. Discusses the environmental harm caused by battery waste and the necessary actions to be taken.	X		

Table 2 was created to express how the environmental objectives in the primary science curricula of different countries are distributed according to grade levels by considering the environmental literacy dimensions. The table shows the number and percentage values of objectives of 2018 Türkiye, 2022 Canada (Ontario), 2018 Australia, 2016 USA (Massachusetts) and 2015 England science curricula.

Table 2. Dimensions according to grade levels in country curricula

Countries	Grade levels	Dimensions of environmental literacy			Total number of objectives
		Cognitive Skills *f (%)*	*Affect* *f (%)*	*Behavior* *f (%)*	
TÜRKİYE	3rd	12 (85,7)	1 (7,1)	1 (7,1)	14
	4th	9 (69,2)	3 (23,1)	1 (7,7)	13
	5th	8 (80)	2 (20)	0	10
	6th	3 (50)	2 (33,3)	1 (16,7)	6
	7th	7 (58,3)	1 (8,3)	4 (33,3)	12
	8th	16 (66,7)	5 (20,8)	3 (12,5)	24
	Total number of objectives	55 (69,6)	1417,7)	10(12,7)	79
CANADA (ONTARIO)	1st	27 (90)	2 (6,7)	1 (3,3)	30
	2nd	23 (92)	2 (8)	0	25
	3rd	26*(92,9)	4*(14,3)	0	28
	4th	27 (100)	0	0	27
	5th	16 (100)	0	0	16
	6th	15*(71,4)	7*(33,3)	1*(4,8)	21
	7th	21 (95,5)	1 (4,5)	0	22
	8th	19 (95)	1 (5)	0	20
	Total number of objectives	174 (92,1)	17 (9)	2 (1,1)	189
AUSTRALIA	Foundation year	6 (75)	2 (25)	0	8
	1st	15 (100)	0	0	15
	2nd	13 (72,2)	5 (27,8)	0	18
	3rd	13 (100)	0	0	13
	4th	19 (82,6)	4 (17,4)	0	23
	5th	11 (84,6)	2 (15,4)	0	13
	6th	25 (86,2)	4 (13,8)	0	29
	7th	33 (82,5)	3 (7,5)	4 (10)	40
	Total number of objectives	135 (84,9)	20(12,6)	4 (2,5)	159
USA (MASSACHUSETTS)	Pre-kindergarten	14 (100)	0	0	14
	Kindergarten	5 (71,4)	1 (14,3)	1 (14,3)	7
	1st	4 (100)	0	0	4
	2nd	6 (100)	0	0	6
	3rd	8 (80)	2 (20)	0	10
	4th	6 (100)	0	0	6
	5th	7 (87,5)	1 (12,5)	0	8
	6th	6 (100)	0	0	6
	7th	12 (100)	0	0	12
	8th	11 (100)	0	0	11
	Total number of objectives	79 (94)	4 (4,8)	1(1,2)	84

ENGLAND	1st	8 (100)	0	0	8
	2nd	8 (88,9)	1 (11,1)	0	9
	3rd	8 (100)	0	0	8
	4th	4 (80)	1 (20)	0	5
	5th	2 (100)	0	0	2
	6th	4 (100)	0	0	4
	Total number of objectives	34 (94,4)	2 (5,6)	0	36

Note: Outcomes marked with * are included in more than one dimension.

According to the findings in Table 2, it is seen that the country program with the highest number of environmental outcomes belongs to the province of Ontario in Canada, followed by Australia, the USA (Massachusetts), Türkiye and the UK programs. Respectively in Türkiye, the science course at the elementary level covers grades 3-8, while the curriculum used in the Ontario covers grades 1-8, the curriculum used in Australia covers basic year-7, the curriculum used in the Massachusetts covers pre-kindergarten-8, and finally the national curriculum used in the UK covers graded 1-6. When the total number and percentages of objectives according to the dimensions in the countries included in the study are examined, it is seen that all country programs have the most objectives related to the cognitive skills dimension. It is understood that this is followed by the affective dimension, and the least number of learning outcomes is related to the behavioral dimension. When the number of achievements at the grade levels in the curricula of the countries are examined one by one, it is seen that there is the highest number of achievements related to the cognitive skills dimension at all grade levels.

When the cognitive skill dimension outcomes are compared according to their percentage values, the cognitive skill dimension is included in the 2015 UK national curriculum with 94.4%. This was followed by the USA (Massachusetts) with 94%, Canada (Ontario) with 92.1%, Australia with 84.9% and Türkiye with 69.6%. When the objectives of the affective dimension are compared according to their percentage values, this dimension is included in the 2018 Turkish curriculum with 17.7%. This is followed by Australia with 12.6%, Canada with 9%, England with 5.6% and the USA with 4.8%. When the behavioral dimension outcomes were compared according to their percentage values, it was seen that the behavioral dimension was included in the Turkish curriculum with the highest percentage of 12.7%. Australia followed this with 2.5%, the USA with 1.2% and Canada with 1.1%.

Table 3 was created to express how the objectives reflecting the dimensions of environmental literacy in the science curriculum of different countries are distributed according to the learning areas. The table shows the number of objectives and percentage values obtained for each dimension according to the learning areas.

Table 3. Dimensions according to learning areas in countries' curricula

Learning area	Dimensions of environmental literacy	Countries				
		Türkiye f (%)	*Canada Ontario f (%)*	*Australia f (%)*	*USA-Massachusetts f (%)*	*England f (%)*
Physics	Cognitive skill	12 (70,6)	21 (95,5)	5 (100)	3 (60)	0
	Affect	4 (23,5)	0	0	1 (0)	0
	Behavior	1 (5,9)	1 (4,5)	0	1 (20)	0
	Total number of objectives	17	22	5	5	0
Chemistry	Cognitive skill	7 (58,3)	31* (96,9)	6 (85,7)	0	3 (100)
	Affect	1 (8,3)	2* (6,3)	1 (14,3)	0	0
	Behavior	4 (33,3)	0	0	0	0
	Total number of objectives	12	32	7	0	3
Biology	Cognitive skill	27 (67,5)	59* (86,8)	49 (89,1)	34 (91,9)	26 (92,9)
	Affect	8 (20)	10* (14,7)	6 (10,9)	3 (8,1)	2 (7,1)
	Behavior	5 (12,5)	1* (1,5)	0	0	0
	Total number of objectives	40	68	55	37	28
Earth and Space Science	Cognitive skill	9 (90)	63* (94)	24 (77,4)	41 (100)	5 (100)
	Affect	1 (10)	5* (7,5)	7 (21,9)	0	0
	Behavior	0	0	0	0	0
	Total number of objectives	10	67	31	41	5
Science	Cognitive skill	-	-	51 (83,6)	-	-
	Affect	-	-	6 (9,8)	-	-
	Behavior	-	-	4 (6,6)	-	-
	Total number of objectives	-	-	61	-	-
Technology	Cognitive skill	-	-	-	1 (100)	-
	Affect	-	-	-	0	-
	Behavior	-	-	-	0	-
	Total number of objectives	-	-	-	1	-

Note: Outcomes marked * are included in more than one dimension

According to the findings in table 3, it is seen that the learning areas of "Physics, Chemistry, Biology and Earth and Space Sciences" are common for all country programs in the study. In addition to these learning areas, there is a "Science" learning area in the Australian science curriculum, while there is a "Technology" learning area in the US (Massachusetts) science curriculum.

In the Turkish science curriculum, environmental objectives are mostly included in the

biology learning area, followed by physics, chemistry and earth and space sciences learning areas, respectively. In all learning areas in the curriculum, the cognitive skills dimension, which is one of the dimensions of environmental literacy, is the dimension with the highest number of outcomes and the highest percentage value. In the curriculum, the learning area with the highest percentage of cognitive skills was earth and space sciences learning area with 90%, while the highest percentage of affective dimension was in physics learning area with 23.5% and the highest percentage of behavioral dimension was in chemistry learning area with 33.3%.

In the Canadian (Ontario) curriculum, there are environmental objectives in the learning areas of physics, chemistry, biology, earth and space sciences. The learning area with the highest percentage value for the cognitive skills dimension is chemistry with 96.9%. Chemistry is followed by physics with 95.5%, earth and space sciences with 94% and finally biology with 86.8%. In the Canadian (Ontario) curriculum, the learning area with the highest number and percentage of the affective dimension is biology with 14.7%, while the behavioral dimension is mostly included in the physics learning area with 4.5%.

In the Australian science curriculum, there are environmental objectives in physics, chemistry, biology, earth and space sciences and science learning areas. According to the data in the table, it is understood that all three dimensions of environmental literacy are included only in the science learning area, while only cognitive skills and affect dimensions are included in the physics, chemistry, biology and earth and space sciences learning areas. It is understood that the science learning area lags behind the other learning areas and the learning area with the highest percentage value is physics with 100%. The learning area with the highest number and percentage of affect objectives was earth and space sciences with 21.9%, while the learning area with the highest number and percentage of behavior learning objectives was science with 6.6%.

In the USA (Massachusetts) science curriculum, there are environmental objectives in the learning areas of physics, biology, earth and space sciences and technology. It is understood that all three dimensions of environmental literacy are included only in the physics learning area; cognitive skills and affect dimensions are included in the biology learning domain, while only cognitive skills are included in the earth and space sciences and technology learning areas. The learning area with the highest percentage of cognitive skill dimension is Earth and space sciences and technology with 100%. The learning area with the highest percentage of affect dimension was physics with 20%, while the learning area with the highest percentage of behavior dimension was physics with 20%.

In the UK National Science Curriculum, there are environmental objectives in the learning areas of chemistry, biology, earth and space sciences. Since all environmental objectives in chemistry and earth and space sciences learning areas reflect the cognitive skill dimension, their percentage value is 100%. For this reason, chemistry and earth and space sciences were the learning areas with the highest percentage of cognitive skills in the curriculum. The learning area with the highest percentage of affect dimension is biology with 7.1%. The behavior dimension was not encountered in any learning area.

According to the grade levels and learning areas, it was observed that the cognitive skills dimension was the most common in all country programs in this study, followed by the affect and behavior dimensions respectively.

In this study, additionally, thematic analyses of environmental learning outcomes in the curricula were also conducted. When considering the codes developed throughout the study, categories were created by grouping similar codes under headings. There are seven categories: "The Needs of Living Things, The Characteristics of Living Things, Classification of Living Things and Biological Diversity, Ecosystems and Interactions, Systems of the Earth, Earth and Human Activity, and Ways of Environmental Protection." In the 2018 Turkish Science Curriculum, the category "Ways of Environmental Protection" is included at all grade levels, while the category "The Needs of Living Things" is not included at any grade level. It is understood that the category "The Needs of Living Things" is not addressed in any learning area, while the categories "Systems of the Earth" and "Earth and Human Activity" are included in all learning areas.

In the Canadian (Ontario) curriculum, it is observed that the themes "Ecosystems and Interactions" and "Earth and Human Activity" are included at all grade levels. On the other hand, the theme "The Needs of Living Things" is the least represented theme in the curriculum. It is also noted that the themes "Ecosystems and Interactions," "Earth and Human Activity," and "Ways of Environmental Protection" are addressed across all learning area.
In the Australian science curriculum, when comparing grade levels, the category "The Needs of Living Things" is the least represented in the curriculum. The categories "Systems of the Earth" and "Earth and Human Activity" are included at all grade levels. Among the learning areas, the only category present across all of them is "Earth and Human Activity."
In the USA (Massachusetts) science curriculum, while the category "The Needs of Living Things" appears at the fewest number of grade levels, the category "Systems of the Earth" is present across all grade levels. When environmental learning outcomes are examined by learning areas, it is observed that the category "Ways of Environmental Protection" is the most frequently represented across the areas.

In the UK National Science Curriculum, when the categories are analyzed by grade levels, it is observed that the category "Ways of Environmental Protection" is not included at any grade level, while the categories most frequently included across grade levels are "Classification of Living Things and Biological Diversity" and "Ecosystems and Interactions." When environmental learning outcomes are examined by learning domains, it is understood that the category "Ways of Environmental Protection" is not present in any learning area, whereas the most represented category across the learning areas is "Ecosystems and Interactions."

Considering all the findings, it is evident that environmental education is relatively limited in the Turkish science curriculum, with a noticeable decline in environmental learning outcomes at higher grade levels. In contrast, the curricula of Canada and Australia adopt a more holistic approach to environmental literacy.

Discussion, Conclusion and Recommendations

In this study, since it is thought that investigating the extent to which the science curricula of the countries that have shown success in international exams (PISA-TIMMS) address the dimensions of environmental literacy and comparing the results with the current science curriculum in Türkiye will be meaningful and important in terms of giving ideas to the curriculum developers in our country, programs from countries that have shown success in international exams and whose language of instruction is English were selected and comparisons were made. The results obtained are explained in this section.

The environmental objectives in the elementary science curricula of different countries were

compared within the framework of grade levels and learning areas by considering the dimensions of environmental literacy, namely cognitive skills, affective and behavioral dimensions. In the study, 2018 Türkiye, 2022 Canada (Ontario), 2018 Australia, 2016 USA (Massachusetts) and 2015 England science curricula were examined. As a result of the comparisons made in the examined curricula, it was understood that the science course in the country's programs differed according to the grade levels at the primary education level. According to the results obtained, it was observed that the science course in Türkiye started later in primary education compared to other countries and covered fewer grade levels. As a result of the comparisons made according to the total number of environmental objectives in the programs, it was seen that the highest number of environmental objectives were found in the Canada-Ontario program with 189 objectives, followed by Australia with 159 objectives, USA (Massachusetts) with 84 objectives, Türkiye with 79 objectives and England with 36 objectives.

The results obtained from the study of Erten et al. (2022) also support the result of the current study. In the study comparing the curricula of the USA, Canada and Türkiye, it was seen that Canada's curriculum had the highest number of environmental outcomes as a result of the comparisons made according to the number of environmental outcomes. When the curricula of the countries were compared in terms of their inclusion of environmental literacy dimensions, it was found that all of the cognitive skills, affective and behavioral dimensions were found in all curricula except the UK Science curriculum, and there were no outcomes related to the behavioral dimension in the UK curriculum. In all the country programs examined, it was observed that the highest number of outcomes related to the cognitive skills dimension was available, followed by the affective dimension, and the least common dimension was behavior. Koto (2020) reached a similar conclusion in her study. She examined the outcomes in the primary school programs of Türkiye and Canada (Ontario) according to their inclusion of UNESCO and UNEP principles and concluded that the outcomes in the science curricula of both countries were mostly in the skills dimension. However, a comprehensive study examining the dimensions of environmental literacy with each component in the curricula of different countries as in this study was not found in the literature, and no other study was found to support the results obtained on behalf of all the countries studied. In the studies comparing literacy dimensions in Türkiye and other countries other than the countries examined in this study, it was found that the knowledge and cognitive skills dimensions were given more space in the programs, while the affective and behavioral dimensions did not receive the same value (Srbinovski, 2010; Bahar, 2013; Erdoğan, 2009). In 2018 Türkiye's science curriculum, the percentage value of the cognitive skills dimension was 69.6%, while the affective dimension corresponded to 17.7% and the behavioral dimension to 12.7%. When the same evaluations were made for other country programs; In the 2022 Canada-Ontario Science curriculum, cognitive skills corresponded to 92.1%, affect to 9% and behavior to 1.1%; in the 2018 Australian science curriculum, cognitive skills corresponded to 84.9%, affect to 12.6% and behavior to 2.5%, In the 2016 US-Massachusetts Science curriculum, cognitive skills corresponded to 94%, affect to 4.8% and behavior to 1.2%, and finally, in the 2015 UK National science curriculum, cognitive skills corresponded to 94.4%, affect to 5.6% and behavior to 0%. When the percentage values of the dimensions in the curricula of the countries examined in the study were examined, it was concluded that the affective and behavioral dimensions were quite incomplete for each country's curriculum, and although the affective and behavioral dimensions were included at a higher rate in the Turkish science curriculum compared to the other four country curricula, they still did not have sufficient percentage values. Similar results of this study were also found in Derman's (2015) study. In the study, the science curricula of Australia, Singapore, Ireland and Canada

were compared with the Turkish curriculum, and it was concluded that all of the curricula did not include a sufficient level of objectives in terms of producing solutions to problems and providing skill acquisition, and that the achievements related to the affective domain were also not at a sufficient number and level. For individuals to be qualified as environmentally literate, they need to reflect on their ideas and skills to protect the environment to their behaviors. In their studies, Hungerford and Tomara (1977), while explaining the aims of environmental education, especially emphasized the realization of positive actions towards the environment at the point of raising environmentally literate individuals.

In the Turkish curriculum, it was observed that the environmental literacy dimensions had a more balanced distribution according to the grade levels in each grade level, while there was no balance between the dimensions and grades levels in the other country curricula. For the Canadian and Australian curricula, the affect dimension has a more balanced distribution compared to the other country curricula, while there is no balance in the distribution of the behavior dimension. In the US program, both the affect and behavior dimensions had an unbalanced distribution, and the number of objectives was quite limited, while in the UK program, it was observed that the affect dimension was insufficient and the behavior dimension was not included at all. However, all dimensions are very important for environmental literacy.

When the objectives in the country curricula were compared within the framework of learning areas according to the environmental literacy dimensions, it was observed that the learning areas of "Physics, Biology and Earth and Space Sciences" were common to all country curricula in 2018 Türkiye, 2022 Canada-Ontario, 2018 Australia, 2016 USA-Massachusetts and 2015 UK, while the learning domain of "Chemistry" was included in all programs except the USA-Massachusetts curriculum. In the USA curriculum, the objectives reflecting the chemistry learning area were included under the physical sciences learning area. In the 2018 Australian curriculum, in addition to these learning areas, it was determined that the "Science" learning area was available and in the 2016 US-Massachusetts curriculum, in addition to these learning areas, the "Technology" learning area was available.

The highest value (100%) for the cognitive skill dimension in the physics learning area was found in the Australia's curriculum. The highest value for the affect dimension (23.5%) was found in the Turkish curriculum. In the behavioral dimension, the country curriculum with the highest rate was USA-Massachusetts with a value of 20%.

The country curriculum with the highest value in the cognitive skill dimension in the chemistry learning area was England with 100%. While the highest value for the affect dimension was found in the Australian curriculum with 14.3%, the country curriculum with the lowest value was Canada with 6.3%. The behavior dimension was only found in the 2018 Turkish science curriculum. With 4 objectives, its percentage value is 33.3%.

In the comparison made according to percentage values in the biology learning area, the UK science curriculum was ahead of other country curricula with a value of 92.9%. While the affect dimension was found in all country curricula, the highest number of objectives (10) was seen in the Canadian curriculum, but the country curriculum with the highest value was the 2018 Türkiye curriculum with 20%. In the behavior dimension, the highest number (5) and percentage (12.5%) objectives were again found in the 2018 Türkiye curriculum.

In the comparisons made according to percentage values in the earth and space sciences

learning area, the country programs with the highest value in the cognitive skill dimension were the USA and the UK with 100%. All of the environmental objectives available in this learning area reflect the cognitive skill dimension. The highest number (7) and percentage (21.9%) objectives in the affect dimension were found in the 2018 Australian science curriculum. The behavior dimension is not available in any country curriculum.

Science learning area is only available in the 2018 Australian Science curriculum. While the highest number (51) and percentage (83.6%) of objectives are found in the cognitive skill dimension, this dimension is followed by affect dimension with 6 objectives (9.8%) and behavior dimension with 4 objectives (6.6%).

The technology learning area is available only in the 2016 USA-Massachusetts science curriculum. It was observed that there was only one objective in this learning area and this objective reflected the cognitive skill dimension.

In order to raise environmentally literate individuals, there should be an increase in the number and quality of learning objectives reflecting affect and behavior in the curricula. It would be useful to update the cognitive skill objectives numerically and in a way that requires higher level cognitive thinking according to Bloom. In order to improve students' skills such as generating solutions to problems and evaluating solution proposals, objectives related to these skills can be added to future programs. For the acquisition of affective and behavioral acquisitions, more care and attention can be paid at the point of application. It may be useful to add and implement objectives related to environmental education in such a way that the lessons are carried out in the natural environment.

This study is a study in which only the curricula of the countries were analyzed according to the dimensions of environmental literacy. In future studies, textbooks and activities prepared in accordance with the curricula can also be examined in terms of their level of reflecting the dimensions of literacy. This research was conducted only for elementary science curricula. Environmental education is an interdisciplinary field; therefore, curricula from other disciplines can also be examined. This research is a study comparing the curricula of Canada, USA, Australia and England with the curriculum in Türkiye. Programs of different countries that have achieved success in international exams can also be examined comparatively.

Declarations

Note: This article is based on the research conducted by Deniz Yücel under the supervision of Assoc. Prof. İlke Çalışkan and entitled “A Comparative Examination of Environmental Literacy in Different Countries' Science Curriculum” derived from her master's thesis.

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Data availability: The data produced and examined in this work can be obtained upon request from the corresponding author.

References

Akçay, S. (2024). Comparison of Turkish science curricula and British science curriculum in terms of environmental education. *Journal of Human and Social Sciences Research*, *13*(5), 1852-1872.

Aynal, S. (2012). Comparative Education Identity, (Ed: Aynal, S.), Reflections on comparative education. (1st Edition), Pegem Academy: Ankara. p. 217.

Barak, B., & Gönençgil, B. (2020). A comparison of middle school curricula in the world and in Turkey based on the climate change education approach. *Journal of Geography*, (40), 187–201.

Baykal, H. & Baykal, T. (2008). Environmental problems in a globalizing world. *Mustafa Kemal University Journal of Institute of Social Sciences, 5*(9).

Bekdaş, U. (2019). *An analysis of 'environmental learning outcomes in the 2018 middle and high school curricula of the Ministry of National Education* (Unpublished Master's Thesis). Necmettin Erbakan University, Institute of Educational Sciences, Konya.

Bozkurt, O., & Cansüngü Koray, Ö. (2002). Misconceptions of primary school students regarding the greenhouse effect in environmental education. *Hacettepe University Journal of Education, 23*, 67-73.

Brown, A. S. & Brown, L. L. (2007). What Are Science and Math Test Scores Really Telling Us? *The Ben of Tau Beta Pi,* 13-17.

Carter, R. L., & Simmons, B. (2010). The history and philosophy of environmental education. *The inclusion of environmental education in science teacher education*, 3-16.

Cebesoy, Ü. B. & Dönmez Şahin, M. (2010). A comparative analysis of the lower secondary science and technology curriculum in terms of environmental education. *Journal of Biological Sciences Research, 3*(2), 159-168.

Derman, M. (2015). *A comparative analysis of environmental education in primary and secondary science curricula of different countries* (Unpublished doctoral dissertation). Atatürk University, Institute of Educational Sciences, Erzurum.

EARGED. (2003). *The third international mathematics and science study: National report*. Ministry of National Education.

Eken, A. (2010). *An analysis of environmental topics in high school biology curricula of different countries* (Unpublished master's thesis). Gazi University, Institute of Educational Sciences, Ankara.

Erten, S. (2005). Investigating environmentally friendly behaviors in preschool teacher candidates. *Hacettepe University Journal of Education, 28*(28), 91-100.

Erten, S., Köseoğlu, P., & Gök, B. (2022). Environmental education in science curricula: Examples from Türkiye, Canada, and the United States. *Mehmet Akif Ersoy University Journal of Education, 63*, 220-246.

Fidan Yazgan, P. (2023). *Comparison of learning outcomes in national science curricula and elective environmental education programs in the context of environmental literacy* (Unpublished Master's thesis). Marmara University, Institute of Educational Sciences, Istanbul.

Fytopoulou, E., Karasmanaki, E., Tampakis, S., & Tsantopoulos, G. (2023). Effects of curriculum on environmental attitudes: a comparative analysis of environmental and non-environmental disciplines. *Education Sciences*, *13*(6), 554.

Güler, E. (2013). *Determining the level of environmental literacy of 8th grade primary school students and examining the students' literacy levels in terms of various variables* (Unpublished master's thesis). Çukurova University, Institute of Social Sciences, Adana.

Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). *Developing a framework for assessing environmental literacy.* Washington, DC: North American Association for Environmental Education. Retrieved from http://www.naaee.net

Hungerford, H. R., & Tomera, A. N. (1977). *Science in the elementary school.* Champaign, IL: Stipes Publishing Company.

Hungerford, H., Peyton, R. B., & Wilke, R. J. (1980). Goals for curriculum development in environmental education. *The Journal of Environmental Education, 11*(3), 42-47.

Hungerford, H. R., & Peyton, R. B. (1986). *Procedures for developing an environmental education curriculum: A Discussion Guide for UNESCO Training Seminars on Environmental Education*. (Environmental Educational Series 22). UNESCO-UNEP International Environmental Education Programme.

Kaya, V. H., & Elster, D. (2019). A critical consideration of environmental literacy: Concepts, contexts, and competencies. *Sustainability*, *11*(6), 1581.

Kılıç, Ü. (2022). *The place and importance of environmental issues in the curricula of primary and secondary education in Turkey* (Master's thesis). Sinop University, Institute of Graduate Education, Sinop.

Kışoğlu, M., Gürbüz, H., Sülün, A., Alaş, A., & Erkol, M. (2010). Environmental literacy and evaluation of studies conducted on environmental literacy in Türkiye. *International Online Journal of Educational Sciences, 2*(3), 772-779.

Knapp, D. (2000). The Thessaloniki declaration: A wake-up call for environmental education? *The Journal of Environmental Education, 31*(3), 32-39. https://doi:10.1080/00958960009598643

Koto, B. (2020). *Evaluation of environmental education in the primary school curriculum according to UNESCO and UNEP principles* (Unpublished master's thesis). Recep Tayyip Erdoğan University, Institute of Social Sciences, Rize.

Morrone, M., Mancl, K., & Carr, K. (2001). Development of a metric to test group differences in ecological knowledge as one component of environmental literacy. *The Journal of Environmental Education, 32*(4), 33-42.

Organisation for Economic Co-operation and Development. (2019). *Assessing scientific, reading and mathematical literacy: A framework for PISA 2019.* Paris: OECD.

Organisation for Economic Co-operation and Development. (2023). *Assessing scientific, reading and mathematical literacy: A framework for PISA 2023.* Paris: OECD.

Özata Yücel, E., & Özkan, M. (2013). A comparison of environmental topics in the 2013 science curriculum and the 2005 science and technology curriculum. *Uludağ University Journal of Education, 26*(1), 237-265.

Palmer, J. (1998). History and development of environmental education. *Florence: Routledge Press.*

Roth, C. E. (1968). *Curriculum overview for developing environmentally literate citizens.* Massachusetts Audubon Society.

Roth, C. E. (1992). *Environmental literacy: Its roots, evolution, and directions in the 1990s*. ERIC/ED348 235.

Srbinovski, M., Erdogan, M., & Ismaili, M. (2010). Environmental literacy in the science education curriculum in Macedonia and Türkiye. *Procedia-Social and Behavioral Sciences, 2*(2), 4528-4532.

Ürey, M., & Aydın, M. (2014). A program analysis of environmental topics in the primary school science and technology curriculum. *e-Kafkas Journal of Educational Research, 1*(2).

Yıldırım, A., & Şimşek, H. (2018). *Qualitative research methods in social sciences*. Ankara: Seçkin Publishing.

Yolcu, O. (2014). *An investigation of the primary school first stage life science and science and technology curricula in terms of environmental education from 2013 to present* (Unpublished master's thesis). Adnan Menderes University, Institute of Social Sciences, Aydın.