Enviromental Education and Sustainable Development

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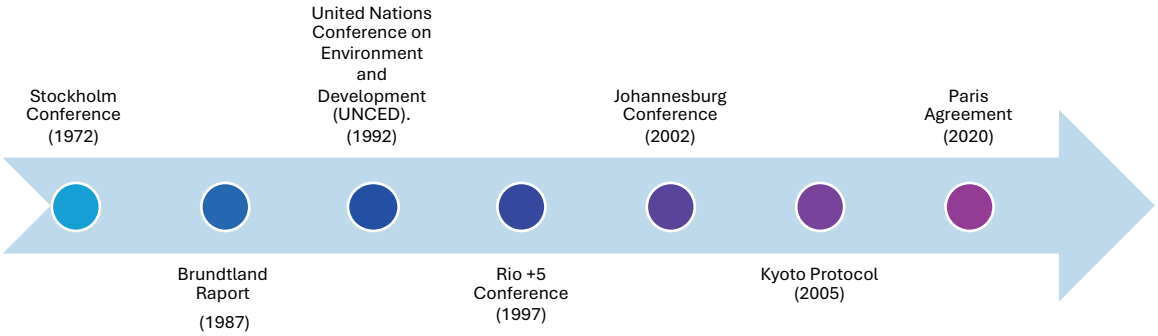
One of the most significant problems threatening humanity is environmental issues. The environment encompasses the physical, biological, social, cultural, and economic conditions in which living beings interact and sustain their relationships (Ministry of Environment and Urbanization, 2018). Factors contributing to environmental problems include deforestation, global warming, acid rain, unplanned urbanization, agricultural fires, erosion, pollution, and the depletion of the ozone layer (Sönmez & Yerlikaya, 2017). Wars and human activities driven by personal interests also exacerbate these issues (Atasoy & Ertürk, 2008). While humans are the primary cause of environmental problems, they are also key to their resolution. Individuals with environmental awareness play a crucial role in addressing these challenges (Erten, 2004; Escobar, 1995).

Environmental issues represent a global problem affecting all humanity, regardless of sociocultural status, race, belief, or language. Although the term "environmental issues" was first defined in 1960 (Gelmez, 2015), it became more prominent over time in industrialized countries. Various meetings were held and agreements were signed to address these problems. At the Stockholm Conference in Sweden in 1972, efforts were made to establish a framework for addressing environmental and economic issues. The conference, attended by 113 countries, led to the establishment of the United Nations Environment Programme (UNEP) to foster partnerships encouraging societies to care for the environment without risking future generations.

The establishment of UNEP marked the beginning of sustainability, emphasizing the conservation of resources for future generations. Among the most notable agreements is the 1977 Tbilisi Declaration, a milestone in environmental education for sustainable development. The declaration outlined environmental education as a solution to environmental issues, detailing its goals and content (Dere and Çinikaya, 2023). The goals of environmental education, as articulated in the Tbilisi Declaration, include raising awareness of the relationships between economic, political, and social conditions in rural and urban life, empowering individuals with the knowledge and skills needed to address environmental problems and fostering positive behaviors toward the environment. In 1987, the concept of sustainable development was introduced in the Brundtland Report (Our Common Future) (Dere & Çinikaya, 2023). Most recently, the 2022 Paris Agreement, signed by 194 countries, established an action plan to reduce greenhouse gas emissions. Sustainable development consists of three key components: environmental, economic, and social. The importance

of environmental sustainability was also emphasized in the Göteborg Report prepared by the European Council (Büyükuslu, 2021; Erişkin, 2019).

Figure 1. *Chronological Order of Enviremental Policies*



In line with the goals of sustainable development, environmental education aims to enable students to understand environmental issues, develop solutions, and comprehend the complexity and functioning of environmental systems (Davis, 1998). Sustainable environmental education targets the preservation and responsible use of natural resources to ensure the well-being of future generations. By shifting from an anthropocentric (human-centered) perspective to an ecocentric (environment-centered) approach, the pressure humans exert on nature can be reduced (Gülersoy, 2022). Indeed, as Pandey (2008) argues, it is crucial for individuals to receive quality environmental education in today's world, where environmental issues significantly impact human life.

The United Nations announced the 2030 Global Sustainable Development Goals to address these challenges (UNESCO, 2018). Environmental education must align with these goals to enhance awareness of environmental issues. Additionally, the principles of environmental education outlined in the Tbilisi Declaration are crucial for success. These principles emphasize:

- Environmental education should begin in early childhood and continue at all levels throughout life.
- Pupils should acquire knowledge about environmental conditions across all geographic regions and evaluate environmental problems from regional, national, and international perspectives.
- The importance of cooperation at regional, national, and international levels should be highlighted in taking measures and finding solutions to environmental problems.
- Cultural and historical contexts should be considered in addressing existing and potential environmental conditions in education.
- Environmental education should allow students to take on roles, make decisions, and accept the consequences of their decisions through well-planned learning experiences.
- It should help students identify the root causes of environmental problems.
- Environmental education should provide environmental awareness, sensitivity, knowledge, and problem-solving skills, taking into account the developmental stages and ages of students. Special attention should be given to fostering environmental awareness in younger age groups.

- Environmental education should offer hands-on learning opportunities. Teachers should design diverse and practical learning environments for their pupils.

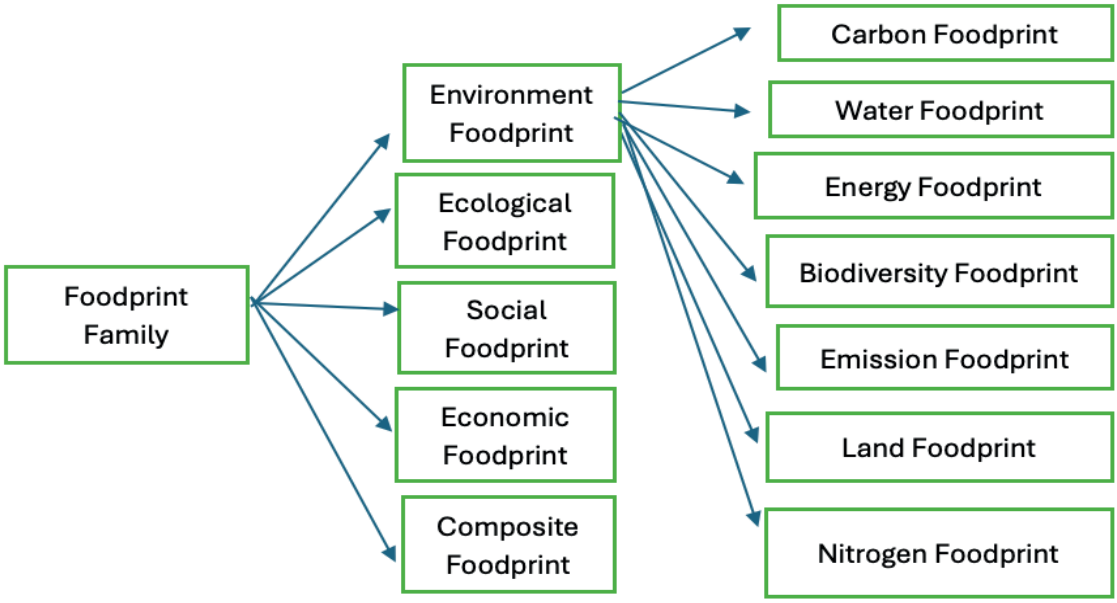
Sustainable environmental education plays a vital role in addressing global environmental issues by fostering a shift in perspective and promoting the permanence of environmentally conscious behaviors (Forinash, Perkins, & Whitten, 2021). Roth (1992) underscores that environmental education must be experiential to achieve its objectives. In this context, sustainable environmental education is implemented differently across countries. Some, like Austria and Denmark adopt an interdisciplinary approach, while others, such as Finland and Belgium, include it as a distinct subject in their curricula (Özata Yücel & Özkan, 2013). Glasser and Hirsh (2016) highlight the importance of facilitating societal transformation toward sustainability and enhancing individual capacities to achieve sustainability goals. Introducing environmental education early in childhood is particularly critical.

A review of the literature on sustainability education reveals a wide range of studies on its scope and practices (Tanrıverdi, 2009). Various perspectives exist regarding the learning outcomes of education intended to be delivered from early childhood to higher education levels. Analysis of sustainable environmental education programs indicates that topics such as ecological footprint, carbon footprint, water footprint, and biodiversity are emphasized in these curricula.

Ecological Footprint

The ecological footprint family is considered one of the most critical pillars of sustainability. Footprints are used to evaluate ecological systems. Each footprint, which reveals human pressure and impacts on the environment, is calculated individually, and the system is assessed holistically (Hoekstra & Mekonnen, 2014). The ecological footprint family is illustrated in Figure 2.

Figure 2. *Foodprint Family (Hoekstra ve Mokennan, 2014*)



The footprint family included in environmental education is interconnected and mutually influential. In sustainable science education, terms such as ecological footprint, water footprint, carbon footprint, and biodiversity are emphasized in curricula from primary to college education.

The ecological footprint is defined as the amount of water and land required to mitigate the negative impacts arising during the production and consumption of a product (WWF, 2012). This concept quantifies the consumption of natural resources by calculating the biologically productive area needed (Akıllı et al., 2008). The calculations provide a basis for determining measures to ensure the sustainability of existing resources.

Image 1. *Ecological Foodprint*

According to the Living Planet Report (2012), the components of the ecological footprint are categorized into six groups: carbon, grazing land, forests, fishing grounds, cropland, and built-up land. The ecological footprint was first calculated by Wackernagel and Rees in 1997, and a second calculation method was introduced by WWF (2012) based on the ecological footprint hypothesis.

Ecological foodprint: Consumption × Production Area × Population

In the ecological footprint formula, the term “consumption” represents the level of product usage, while the term “production” refers to the biologically productive area required to sustain consumption within certain limits. According to the global ecological footprint ranking published by WWF (2024), China has been identified as the country with the highest footprint. The top 10 countries in the ecological footprint ranking are presented in Table 1.

Table 1. *Ranking of Countries Ecological Foodprint*

Country	Total ecological foodprint (Global Hectares)
China	5.1 Billion Hectares
USA	2.6 Billion Hectares
India	1.5 Billion Hectares
Russia	848 Billion Hectares
Brazil	551 Billion Hectares
Japan	533 Billion Hectares
Indonesia	454 Billion Hectares
Germany	392 Billion Hectares
Mexico	315 Billion Hectares
France	312 Billion Hectares

The World Wide Fund for Nature (WWF) has identified a series of measures to be taken at the national level to reduce ecological footprints. These include: creating natural parks that support the harmonious coexistence of humans and animals with nature, ensuring the continuity of biodiversity, eliminating practices that put pressure on species and hinder sustainability, ending production and consumption practices that harm humans, plants, and animals implementing decisions related to biodiversity and conservation areas, creating and protecting habitats for animals and emphasizing environmental education to ensure the balanced coexistence of living organisms.

Carbon Footprint

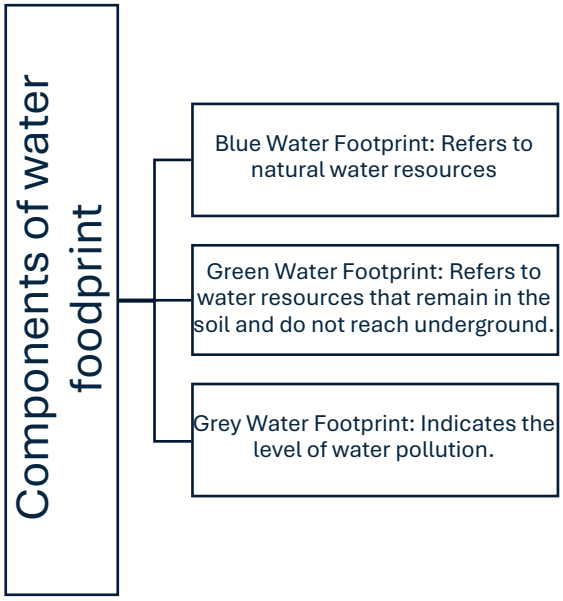
The carbon footprint, the largest component of the ecological footprint, represents the impact of human activities on nature to meet our needs (Lynas, 2009). Due to the significant contribution of carbon dioxide emissions among greenhouse gases, it is a primary driver of global warming. For this reason, greenhouse gases are often converted to carbon dioxide equivalents in calculations (Wiedmann & Minx, 2008). The carbon footprint encompasses various parameters, ranging from transportation to food consumption (Kitzes et al., 2008). These parameters also reveal insights into the sociocultural and socioeconomic levels of countries, as consumption habits and lifestyles are reflected in their carbon footprints (Jones & Kammen, 2011). Excessive consumption behaviors disrupt the ecological balance and increase pressure on nature. However, fostering environmental awareness from an early age and understanding the impact of human activities can help individuals reduce their carbon footprints.

Water Footprint

In addition to the carbon footprint, another significant term in environmental education is water awareness. While the amount of accessible freshwater on Earth is limited, global population growth is making access to water increasingly difficult (Aslanova, 2015). According to data from the Turkish Statistical Institute (TUIK), Turkey's population will reach 100 million by 2030. Therefore, it is crucial to pay attention to the efficient use of water. Although Turkey has not experienced below-average rainfall for many years, there are issues with drinking water reserves

(DSI, 2023). In this context, a national water mobilization project has been implemented. The goal of the water mobilization project is to ensure the sustainability of water resources. Sustainable water management is based on the implementation of water efficiency technologies and the alteration of human behaviors to ensure proper water management (Ministry of Agriculture and Forestry, 2024). According to the Finnish Environment Institute (2019), virtual water use should also be considered in ensuring water sustainability. Virtual water refers to the amount of water consumed throughout the life cycle of a product, from the use of raw materials to the processing of waste (WWF, 2024). For example, 10,850 liters of virtual water are used to produce a single pair of jeans. Therefore, the calculation of water footprints and raising awareness about unconscious water usage is essential. The water footprint not only provides information about water capacity but also offers insights into where and how water is used (Hoekstra & Mekonnen, 2012). The components of the water footprint are shown below.

Figure 3. *Components of the Water Foodprint (Hoekstra ve Mekonnen, 2012)*



Taking measures to reduce the water footprint will reduce the likelihood of water shortages in the future. In this context, various precautions have been proposed in the literature. These include:

- Encouraging individuals to calculate their water footprint to raise water awareness.
- Implementing water conservation measures.
- Including water footprint education in environmental training to reduce behaviors that increase water usage.
- Reviewing energy consumption and water-saving criteria when purchasing products.
- Collaborating with non-governmental organizations (NGOs) to focus on reducing the water footprint.
- Limiting agricultural land by using modern irrigation methods.
- Choosing crops with lower water footprints.

- Utilizing water purification systems.
- Paying attention to the use of agricultural chemicals.

Energy Footprint

The energy sector and energy policies are intertwined with many other sectors. Managing food and agricultural resources requires a significant amount of energy (Food and Agriculture Organization, 2015). Achieving food production with optimal energy consumption has led to a shift towards renewable energy sources to meet heating needs. Since the environmental footprint occurs during the supply phase of chains such as water, food, and energy, it is important to take necessary precautions to reduce the high environmental impact (Reynolds et al., 2016).

Emission Footprint

The concept of sustainable development refers to reaching the level of developed countries by making improvements in socio-cultural and economic factors for a country. One of the key indicators of a country's development level is its emission footprint. 46% of the emission footprint consists of carbon footprint (Lenzen et al., 2018). Therefore, limiting consumption activities that cause carbon emissions will reduce the greenhouse gas emission rate. Individual vehicle use, fossil fuel consumption, and industrial activities lead to an increase in greenhouse gas emissions. In line with sustainable development goals, increasing environmental awareness, limiting fossil fuel use, and imposing carbon taxes on organizations that emit carbon will contribute to reducing the emission footprint.

Land Footprint

Half of the habitable land on Earth is used for agriculture. For some food crops, less land is used, while for others a lot of land area is used. Land use for food crops determines the land footprint. The land footprint varies from farmer to farmer. However, there may be differences in land footprints depending on where and how food products are produced. The balance of agricultural land is considered important to protect rural life and ecological balance (Ritcie and Roser, 2021).

Nitrogen Footprint

The nitrogen footprint refers to the reactive nitrogen that results from human activities. In particular, the consumption of fossil fuels leads to an increase in nitrogen levels (Cucek et al., 2012). To ensure a sustainable environment, necessary measures should be taken to reduce the nitrogen footprint and a shift towards clean energy sources is recommended.

Biodiversity

Biodiversity is a key term in environmental sustainability education. Biodiversity, which is one of the most important components of an ecosystem, refers to the variety of life and living forms (Yörek, 2006), and is defined as diversity within species, between species, and in ecosystems (Şenel, 2015). According to Granek et al. (2001), it encompasses the diversity of life on Earth, from genes

to species and ecosystems. Biodiversity is examined at three different levels: genetic, species, and ecosystem diversity (Perktaş, 2012). Genetic diversity refers to the survival of endangered species, and populations with high genetic diversity tend to have higher resistance to diseases (Çiftçi, 2019). Species diversity is the difference between species within an ecosystem (Levine et al., 2000). Species diversity is also expressed as genetic diversity (Gündüz, 2011). The ecosystem in which an organism can continue its natural life provides global differentiation (Granek et al., 2001).

The preservation of biodiversity is necessary for sustainable development and creates strategic power for countries in both economic and ecological contexts (Kekillioğlu, 2023). The greatest factor negatively affecting biodiversity is humans (Çelik, 2010). The decline in biodiversity can threaten agriculture and fishing, causing economic losses (Costanza et al., 1997), lead to the increase of infectious microorganisms, creating risks to public health (Keesing et al., 2010), impact carbon storage capacity by the loss of various species, resulting in higher greenhouse gas levels and cause food insecurity. Therefore, it is important to implement measures to protect biodiversity. Some of the measures suggested in the literature for protecting biodiversity include the establishment of gene banks for endangered species and the protection of endangered species. Environmental education should continue, and public awareness should be raised. Necessary sanctions should be applied against illegal hunting (Kekillioğlu, 2023).

Image 2. *Biodiversity Visualisation*

In summary, the conscious use of existing resources and the reduction of all kinds of human activities that put pressure on the natural environment affect ecosystems, biodiversity, ecological footprint and thus sustainability. In this context, raising environmental awareness of individuals will contribute to producing solutions to environmental problems, which are among the biggest problems of today. As a matter of fact, the Global Foodprint Network (GFN), which explains the limit of measuring the resources of the world by humans, announced Turkey's limit exceeding day as 28 July as of 2024. Therefore, it is very important to raise environmental awareness in the context of our country. Environmental education plays a role in the formation of environmental awareness, the development of positive attitudes of individuals towards the environment and the permanence of the developed behaviours. In line with the sustainable approach, environmental education is expected to affect the quality of life of future generations. Environmental education should be included in the teaching process in the context of sustainable development goals, which

are emphasised among the aims of the new curricula, and it is important to carry out practices in terms of creating environmental awareness in students.

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