A PACKAGING WASTE RECOVERY EDUCATION PROGRAM (PWREP) AND ITS IMPACT ON MIDDLE SCHOOL STUDENTS' ENVIRONMENTAL LITERACY AND ENVIRONMENTALLY RESPONSIBLE BEHAVIOUR

by

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ABSTRACT

A PACKAGING WASTE RECOVERY EDUCATION PROGRAM (PWREP) AND ITS IMPACT ON MIDDLE SCHOOL STUDENTS' ENVIRONMENTAL LITERACY AND ENVIRONMENTALLY RESPONSIBLE BEHAVIOUR

This study aimed to develop, implement, and evaluate an educational program on Packaging Waste Recovery for middle school students using project-based learning. It investigated the program's impact on students' environmental literacy, i.e., environmental knowledge, attitudes, and skills, including environmentally responsible behavior, as well as knowledge and attitude toward recovery. The study used a quantitative research method, designed as a quasi-experimental with a nonequivalent control group, pretest-posttest. Nineteen seventh-grade students participated in the *Packaging Waste Recovery Education Program* (PWREP), which the researcher designed and implemented over 12 lessons. Data collected before and after the instructional period were analyzed to evaluate shifts in students' environmental literacy levels and their knowledge and attitudes toward packaging waste recovery. Six instruments were used to measure the program's effectiveness. The researcher adapted two instruments for middle school students and developed the rest. The results showed significant improvements in environmental knowledge, affective disposition toward the environment, environmental problem-solving skills, and environmentally responsible behavior. Students exhibited more favorable attitudes toward recycling and waste recovery, and their knowledge about packaging waste recovery increased significantly. Overall, the *Packaging Waste Recovery Education Program* positively influenced students' environmental literacy and responsible behavior. Qualitative data from semi-structured interviews revealed substantial gains in conceptual and procedural knowledge, positive behavioral and attitudinal changes, and a solution-oriented approach to environmental issues. This study demonstrates the effectiveness of the *Packaging Waste Recovery Education Program* in fostering environmental literacy and suggests the potential of integrating similar programs into mainstream education for a comprehensive and sustainable impact.

ÖZET

AMBALAJ ATIKLARININ GERİ KAZANILMASI EĞİTİM PROGRAMININ ORTAOKUL ÖĞRENCİLERİNİN ÇEVRE OKURYAZARLIĞI İLE ÇEVREYE KARŞI SORUMLU DAVRANIŞLARINA ETKİSİ

Bu çalışma, proje tabanlı öğrenme yöntemini kullanarak ortaokul öğrencileri için Ambalaj Atıklarının Geri Kazanımı üzerine bir eğitim programı geliştirmeyi, uygulamayı ve değerlendirmeyi amaçlamıştır. Programın öğrencilerin çevre okuryazarlığı, yani çevreye karşı sorumlu davranışlar da dahil olmak üzere çevresel bilgi, tutum ve becerilerinin yanı sıra çevresel bilgi ve geri kazanıma yönelik tutumları üzerindeki etkisi araştırılmıştır. Çalışmada nicel araştırma yöntemi kullanılmış, eşdeğer olmayan bir kontrol grubu ile yarı deneysel olarak tasarlanmış, ön test-son test kullanılmıştır. On dokuz yedinci sınıf öğrencisi, araştırmacının tasarladığı ve 12 ders boyunca uyguladığı *Ambalaj Atıkları Geri Kazanım Eğitim Programı*na katılmıştır. Uygulamadan önce ve sonra toplanan veriler, öğrencilerin çevre okuryazarlığı seviyelerindeki değişiklikleri ve ambalaj atıklarının geri kazanımına yönelik bilgi ve tutumlarını değerlendirmek için analiz edilmiştir. Programın etkililiğini ölçmek için altı araç kullanılmıştır. Araştırmacı, iki aracı ortaokul öğrencileri için uyarlamış ve geri kalanını geliştirmiştir. Sonuçlar, çevresel bilgi, çevreye yönelik duyuşsal eğilim, çevresel problem çözme becerileri ve çevre karşı sorumlu davranışlarında önemli gelişmeler olduğunu göstermiştir. Öğrenciler, geri dönüşüm ve atık geri kazanımına karşı daha olumlu tutumlar sergilemiş ve ambalaj atıklarının geri kazanımı konusundaki bilgileri önemli ölçüde artmıştır. Genel olarak, *Ambalaj Atıkları Geri Kazanım Eğitim Programı* öğrencilerin çevre okuryazarlığını ve sorumlu davranışlarını olumlu yönde etkilemiştir. Yarı yapılandırılmış görüşmelerden elde edilen nitel veriler, kavramsal ve prosedürel bilgilerde önemli kazanımlar, olumlu davranışsal ve tutumsal değişiklikler ve çevre sorunlarına çözüm odaklı bir yaklaşım ortaya koymuştur. Bu çalışma, *Ambalaj Atıkları Geri Kazanım Eğitim Programı*'nın çevre okuryazarlığını geliştirmedeki etkiliğini vurgulamakta ve benzer programların genel eğitim sistemine entegre edilmesinin kapsamlı ve sürdürülebilir bir etki yaratma potansiyeline sahip olduğunu önermektedir.

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LIST OF SYMBOLS/ABBREVIATIONS

Abbreviation	Explanation
ADTES	The Affective Disposition Toward Environment Scale
CE	Circular Economy
CREBS	Children's Responsible Environmental Behavior Scale
EE	Environmental Education
EKT	Environmental Knowledge Test
EL	Environmental Literacy
ERB	Environmentally Responsible Behavior
ESD	Education for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation Nature and Natural Resources
MoNE	Ministry of National Education
MoEUCC	Ministry of Environment, Urbanization and Climate Change
NAAEE	North American Association for Environmental Education
OECD	Organization for Economic Cooperation and Development
PjBL	Project-Based Learning
PIPSSTE	Problem Identification and Problem-Solving Skills Test Towards Environment
PWRAT	Packaging Waste Recovery Achievement Test
PWREP	Packaging Waste Recovery Education Program
SDG	Sustainable Development Goal
UN	United Nations
UNEP	United Nations Environmental Program
UNESCO	United Nations Education Scientific and Cultural Organization

1. INTRODUCTION

Living conditions have improved since the Industrial Revolution, but population growth has increased significantly. As of 2022, the world's population has reached 8 billion and is expected to increase to around 10 billion by 2058. Since 1970, the environmental impact of human activities has exceeded the Earth's capacity to regenerate, coinciding with a doubling of the global population and a 400% increase in gross domestic product (GDP) (WWF, 2020). Developed countries, with higher GDPs compared to developing nations, consume more natural resources and materials (WWF, 2020). Additionally, the production of essential food crops such as wheat, rice, maize, and soy has risen exponentially. Agricultural practices and over-exploitation have been the primary causes of species loss (WWF, 2020). The rapid rise of industrialization and a consumption-driven modern lifestyle have had an unprecedented impact on natural resources and ecosystems, leading to numerous environmental challenges (Erdoğan, 2009; Hollweg et al., 2011). Atmospheric carbon dioxide levels are now at their highest in at least 800,000 years. Wildlife populations have plummeted, with a 69% decrease observed globally between 1970 and 2018 (WWF, 2022). Additionally, 60 to 70 percent of the world's forests are endangered due to harmful human activities, which also disrupt microclimates and species habitats. The growing human population exacerbates various environmental issues, including biodiversity loss, deforestation, air, soil and water pollution, excessive natural resource consumption, urbanization, and solid waste production. The growing population, its increasing needs, especially for food, the rise in per capita consumption over the years, and longer human lifespans compared to the past have escalated the hostile pressure humans exert on nature day by day. Although the world has been accustomed to change for millions of years, this pressure, which intensified after the Industrial Revolution, has begun to push the planet to its limits quickly.

With the Industrial Revolution, both consumption and production increased. The amount of waste has also increased, correlating with the surplus production driven by the rising consumption. Most of these wastes are packaging wastes. Packaging has made life more convenient for people leading fast-paced lifestyles but has also contributed to increased consumption through its design. Packaging protects products during shipping and storage and offers marketing benefits to manufacturers. However, a substantial portion of municipal solid waste comprises containers and packaging, making up 28.1% of the total waste (Environmental Protection Agency, 2020). Packaging materials increased by one-fifth in almost ten years in EU countries (20.1%, from 2009 to 2020). According to the OECD (2022), global plastic waste production has doubled over the past two

decades. Roughly two-thirds of this plastic waste lasts less than five years, with 40% derived from packaging, 12% from consumer products, and 11% from textiles and clothing. Only 9% of plastic waste is effectively recycled.

According to the OECD (2019), 90% of municipal waste is sent to landfills in Turkey, whereas 50% is sent to landfills in the USA in 2018 (EPA, 2020). In both developed and developing countries, particularly in Turkey, most solid municipal waste, including plastics, is primarily disposed of in landfills. This waste disposal method has severe negative environmental impacts, such as the depletion of natural resources and the emissions from transportation; the release of methane gas, which is explosive and contributes to the greenhouse effect; air pollution and acid rain resulting from waste incineration; and the production of toxic substances when plastics are burned. Solid waste and air and water pollution are among Turkey's top three environmental problems (MoEU, 2019; 2020). With the increase in production and consumption, waste has become one of the global problems, considering the environmental problems it creates regarding the world's sustainability. There is a need for societies and individuals to produce and consume more responsibly. Sustainable production and consumption, one of the SDGs set by the United Nations in 2015, is also an agenda for the world of education.

Today, it is increasingly clear that the escalating consumption of finite natural resources cannot be addressed solely through legislation, government policies, or scientific and technological innovations. Every individual impacts material consumption, energy use, and decision-making through their daily behaviors. Altering individuals' attitudes and behaviors toward the environment is essential for sustaining environmental development and supporting life on Earth. Environmentally conscious individuals make logical and informed choices in their daily lives to preserve the quality of the environment and consider potential environmental consequences when making decisions. Such positive actions towards nature are known as environmentally responsible behaviors (Osbaldiston & Schott, 2012) and are critical traits of responsible citizens (Roth, 1992).

The necessity for individuals to embrace environmentally responsible behaviors, as highlighted above, is deeply rooted in the principles of environmental literacy. This form of literacy extends beyond mere knowledge acquisition; it involves a transformative journey where individuals develop a profound understanding of environmental issues and are motivated to translate this knowledge into concrete actions that promote environmental sustainability. As people become more environmentally literate, they are better equipped with the awareness, values, attitudes, and skills necessary to make

choices that reflect a commitment to environmental stewardship. This evolution from awareness to action is a critical link in realizing the practical implications of environmental literacy. It empowers individuals to actively participate in environmental conservation and sustainable practices, moving from passive understanding to active, informed decision-making. This shift is essential to overcome the limitations of relying solely on legislative and technological solutions. Through environmental literacy, individuals can grasp the impact of their everyday choices and actions on the environment, contributing significantly to environmental sustainability and responsible citizenship.

Environmental literacy is closely connected with the Sustainable Development Goals (SDGs), particularly Goal 12, which emphasizes sustainable production and consumption. This goal aims to reduce the negative environmental impacts of economic activities and highlights the importance of responsible resource utilization. Achieving Goal 12 relies heavily on environmental literacy, which enhances awareness and understanding of environmental issues while encouraging sustainable behaviors and decision-making. Environmental literacy helps individuals and communities contribute to sustainable production and consumption patterns by fostering informed choices. The United Nations' SDGs, including Goal 12, provide a global agenda for improving sustainability and emphasize the importance of environmental literacy in achieving these goals. Therefore, environmental literacy is essential for promoting sustainable production and consumption practices and achieving the objectives outlined in Goal 12 (Da Rocha & Ferreira Neto, 2022; Giagnocavo, 2023).

Although the concepts of environmental literacy (EL) and environmentally responsible behavior, critical outcomes of environmental education, have been recognized globally over the last 30 years, they have only recently gained significant attention within the Turkish environmental education community and literature (Erdoğan et al., 2009; Kışoğlu et al., 2010; Timur et al., 2014). In Turkey, research on EL has primarily been conducted and published since 2008 (Altuntaş & Turan, 2016; Kışoğlu et al., 2010; Yılmaz et al., 2015). According to this body of research, most studies in Turkey have concentrated on defining environmental literacy (Kışoğlu et al., 2010). A review of national and international literature on environmental education indicates that studies addressing scientific process skills, cognitive skills, issue analysis, investigation, and evaluation skills are relatively scarce (Erdoğan, 2009). Other researchers have reached similar conclusions (e.g., Bahar & Kiras, 2017; Timur et al., 2014; Yılmaz et al., 2015).

Integrating environmental literacy with responsible consumption and production practices is critical for addressing the alarming rise in waste generation and its consequent environmental degradation. This urgent need for holistic environmental sustainability, compounded by the heavy impact of packaging on municipal solid waste, is further highlighted by inefficient waste management practices in various countries, leading to resource depletion and pollution (Coskun & Edward, 2020). Enhancing individual awareness and responsibility towards the environment through environmental literacy is key, as it empowers people to make informed choices that align with the United Nations' SDGs, particularly Goal 12, which focuses on sustainable production and consumption (Da Rocha & Ferreira Neto, 2022; Giagnocavo, 2023). In this context, project-based learning (PjBL) emerges as an effective teaching and learning method (Kusnadi et al., 2023), not only enhancing student engagement but also providing hands-on, practical experiences. This approach allows students to engage actively with real-world environmental issues, developing relevant knowledge, skills, and attitudes (Yusup et al., 2021; Zain et al., 2023). PjBL has been explored as an effective strategy to address environmental challenges such as water pollution, air pollution, and waste in education.

Concurrently, waste education, primarily conducted through eco-school practices and environmental education in schools, reveals significant gaps. A limited academic focus on waste management teaching, waste hierarchy, and the 3Rs (reduce, reuse, recycle) underscores a critical area for development (Coskun & Edward, 2020; Jørgensen et al., 2018; Uğulu, 2011). Most studies concentrate on recycling or waste reduction, overlooking the comprehensive approach essential for effective waste education. This limited scope in waste education at the K-12 level impacts the development of attitudes and behaviors related to waste, which is crucial for achieving the environmental sustainability goals discussed earlier (Coskun & Edward, 2020; Uğulu, 2011). Therefore, bridging this gap in waste education is essential for nurturing a more environmentally literate society capable of making decisions that support a more sustainable interaction with our planet.

Considering these limitations, this research aimed to design and implement an intervention program, the *Packaging Waste Recovery Education Program* (PWREP), by using project-based learning (PjBL) as a teaching and learning method based on waste hierarchy including 3Rs (Reduce, reuse, recycle) strategies and prevention of waste. The study involved developing and adopting several instruments to examine its impact on middle school students' environmental literacy across four dimensions: knowledge, cognitive skills-problem solving, affect and environmentally

responsible behavior (specifically), as well as their knowledge and attitudes towards recovery. Additionally, a codebook for a semi-structured interview was produced (Appendix J).

2. LITERATURE REVIEW

2.1. Environmental Education and Education for Sustainable Development

Environmental education (EE) has never been more critical as our planet confronts various environmental crises. Academic research in this field is not just a scholarly pursuit but a crucial endeavor for the survival and sustainability of our ecosystems. Studies, such as those by the Intergovernmental Panel on Climate Change (IPCC, 2021), have highlighted the rapid changes in our climate system, underscoring the urgent need for informed global citizens who can contribute to environmental stewardship. The degradation of biodiversity, as detailed in the Living Planet Report (WWF, 2020), further exemplifies the critical state of our natural world. Environmental education, therefore, stands at the forefront of equipping current and future generations with the necessary knowledge, skills, and attitudes to navigate and mitigate these complex challenges. This research domain spans interdisciplinary fields, drawing insights from environmental science, sociology, psychology, and education to build a comprehensive understanding of how best to educate and engage diverse populations in meaningful environmental action.

Efforts to mobilize education in response to ecological and environmental challenges have evolved, with four distinct waves of education-related responses identified throughout history (Wals & Benavot, 2017). The first wave, nature conservation education, began in the late 19th century and focused on preserving natural habitats and wildlife. The second wave, environmental education, emerged in the 1960s and aimed to develop ecological literacy and encourage changes in environmental behavior and lifestyles. The third wave, sustainability education, gained prominence following the 1992 Earth Summit, emphasizing citizen engagement and capacity building for sustainable development. The fourth and current wave, environmental and sustainability education, integrates elements from previous approaches and highlights the need to rethink humanity's role in the world while promoting global citizenship (Benzer, 2010).

To comprehensively understand the progression of EE, it is essential to look at its historical development. One observes significant landmarks in its evolution by tracing the trajectory of EE. Commencing with Rousseau's seminal work "Emile, or On Education" in 1762 and progressing through pivotal moments such as the publication of "Silent Spring" by Rachel Carson in 1962, each juncture has contributed to the field's maturation. Notably, the "Limits to Growth" report in 1972

(Meadows et al., 1972) was instrumental in challenging prevailing notions of unbounded growth, accentuating the imperative of sustainable development practices.

The following chronology highlights the late 20th-century developments in EE, including significant international conferences and governmental strategies, emphasizing the field's expanding scope and the growing global response to environmental challenges:

1762: Rousseau publishes "Emile, or On Education," advocating for education aligned with nature and laying early philosophical foundations for EE concepts.

1807: Agassiz promotes direct learning from nature among his students, fostering experiential learning methods in EE (McCrea, 2006).

1920: Geddes links environment and education, emphasizing the relationship between humans and their environments (Scottish et al. on the Curriculum, 1999).

1948: The International Union for Conservation of Nature (IUCN) first uses 'environmental education' (Scottish et al. on the Curriculum, 1999).

1962: Rachel Carson's "Silent Spring" raises public awareness about environmental issues, marking a pivotal moment in the modern environmental movement.

1963: The "Countryside in 1970" conference in the UK spurs new initiatives in environmental conservation and education (Scottish et al. on the Curriculum, 1999).

1968: Post-Countryside conferences, the Committee on Education and the Countryside is established in Scotland, marking a shift towards an interdisciplinary approach in environmental education (Scottish et al. on the Curriculum, 1999).

1970: The first Earth Day is celebrated, raising environmental awareness among the general public.

1971: The National Association for Environmental Education, which later became known as the North American Association for Environmental Education, was established by educators to create

materials for environmental education (EE). In 1969, the Journal of Environmental Education published its inaugural issue, outlining the societal importance and goals of EE (Stapp, 1969)

1972: The "Limits to Growth" report was published and is a foundational study in sustainability and environmental science (Meadows et al., 1972). It highlighted the potential consequences of unchecked population and economic growth within the finite bounds of Earth's resources. The report, produced by MIT researchers for the Club of Rome, used computer models to project future scenarios based on resource depletion, pollution, and population growth trends. It warned of the possibility of reaching the Earth's growth limits within a century if these trends were not altered, signaling a population and industrial capacity decline. This pivotal work fundamentally challenged the idea of unlimited growth and highlighted the necessity of sustainable development.

1972: The United Nations Conference on the Human Environment in Stockholm established the United Nations Environment Programme (UNEP), bringing international attention to environmental issues.

1975: UNESCO's International Workshop on Environmental Education was held in Belgrade, Yugoslavia. This conference led to the creation of the Belgrade Charter, which shaped the fundamental framework for environmental education (EE) (McCrea, 2006; McBride et al., 2013). The same year, the UNESCO-UNEP International Environmental Education Programme (IEEP) was initiated, marking a significant step in global EE efforts.

1977: UNESCO and UNEP hosted the First Intergovernmental Conference on Environmental Education in Tbilisi, Republic of Georgia. This conference was crucial in defining EE's goals, objectives, and guiding principles, many of which remain fundamental today, as articulated in the Tbilisi Declaration.

These milestones in EE have laid the groundwork for modern approaches and strategies in the field. The critical EE conferences and declarations, such as the Stockholm Conference (1972), the Tbilisi Declaration (1977), and the Belgrade Charter (1975), have significantly shaped EE globally. The Stockholm Conference was crucial for raising global environmental awareness and established the United Nations Environment Programme, marking a significant shift in recognizing environmental issues (Chen & Martin, 2015). The Tbilisi Declaration emphasized the need to develop knowledge, attitudes, and skills in individuals to engage with environmental issues actively,

providing a framework for EE programs across various educational levels (Chen & Martin, 2015). Similarly, the Belgrade Charter and the Tbilisi Declaration highlighted the role of education in promoting sustainability, offering guidelines for integrating EE into curricula (Fonseca et al., 2011). These documents collectively established principles, guidelines, and frameworks for environmental education and sustainability, catalyzing global environmental awareness and recognizing education's role in promoting sustainability (Robottom, 1987).

The Tbilisi Declaration, a cornerstone document in EE, outlines its key goals and objectives. According to the Declaration (UNESCO, 1978), the primary goals are to foster awareness about the interconnectedness of economic, social, political, and ecological factors, provide knowledge and skills for environmental protection, and encourage behavior that supports environmental well-being.

Specific objectives categorized in the Tbilisi Declaration include (UNESCO, 1978, p.26-27):

Awareness: Raising sensitivity and awareness about the environment and its challenges.

Knowledge: Facilitating a basic understanding of the environment and related issues.

Attitudes: Developing values and feelings of concern for the environment and motivating active participation in environmental protection.

Skills: Building skills for identifying and solving environmental problems.

Participation: Encouraging active involvement in resolving environmental issues at various levels.

These elements emphasize a holistic approach to EE, integrating theoretical understanding and practical engagement to address environmental concerns. In summary, the Stockholm Conference, Tbilisi Declaration, and Belgrade Charter have been significant in EE for establishing foundational guidelines and frameworks for promoting EE and sustainability. These events and declarations have influenced the global discourse on EE, leading to educational programs focused on sustainability and environmental conservation (Robottom, 1987).

1980: The IUCN, UNEP, and WWF published "The World Conservation Strategy," addressing the conservation of biodiversity and sustainable use of non-renewable natural resources, introducing the concept of sustainable development (Scottish et al. on the Curriculum, 1999). Additionally, Hungerford, Peyton, and Wilke released a publication on objectives for curriculum development in EE (McCrea, 2006).

1987: A significant congress on EE was held in Moscow by UNESCO/UNEP.

1990: EE curriculum programs were published in the United States and the United Kingdom (McCrea, 2006).

1992: The United Nations Earth Summit in Rio de Janeiro highlights education's role in achieving sustainable development, leading to Agenda 21.

1996: The United Kingdom released Government Strategies for EE, marking a significant step in formalizing the nation's approach to EE.

1997: The Kyoto Climate Change Conference in Japan acknowledged climate change's significant and influential manifestation at national and international levels (Scottish et al. on the Curriculum, 1999). In the same year, the International Environment and Society Conference in Thessaloniki was held, where it was affirmed that the principles of the 1977 Tbilisi Declaration remained wholly relevant. This conference also established principles for educational adjustments necessary for sustainable environmental practices.

2000: The United Nations Millennium Summit in New York set forth the Millennium Development Goals (MDGs), which included eight objectives to tackle 21st-century challenges. Among these, Goal 2 focused on achieving universal primary education by 2015, highlighting a global commitment to educational advancement.

2002: The United Nations proclaimed the period from 2005 to 2014 as the "United Nations Decade of Education for Sustainable Development (DESD)."

2012: The Earth Summit, also known as the Conference on Sustainable Development, was held two decades after the original Rio Summit. This conference reaffirmed governmental commitments to Education for Sustainable Development (ESD), in line with the Decade’s objectives. A significant outcome was the adoption of the 10-Year Framework of Programs on Sustainable Consumption and Production.

2015: The United Nations adopted the Sustainable Development Goals (SDGs), with Goal 4 emphasizing the importance of quality education to promote sustainability. In 2015, the World

Education Forum in Incheon was a significant milestone in global education, introducing the Education 2030 Framework for Action. This framework prioritized inclusive and equitable quality education and lifelong learning opportunities for everyone, forming the basis for the education targets within the Sustainable Development Goals (SDGs). The Incheon Declaration, adopted at the forum, underscored a global commitment to transforming lives through education, acknowledging its crucial role in achieving sustainable development.

2021: The UNESCO World Conference on ESD, held from May 17 to 19, represented a significant advancement in EE. Adopting the Berlin Declaration, a document outlining comprehensive policies to transform educational approaches globally, marked this significant event. The conference, which brought together global leaders and stakeholders, focused on integrating sustainable development into all education systems. One of the key outcomes was UNESCO's commitment to incorporating EE into curricula worldwide by 2025, addressing the urgency for education systems to effectively respond to environmental crises and sustainability challenges (UNESCO, 2021).

The Berlin Declaration emphasized transforming learning through various means, including teaching, learning, professional training, and civic engagement. It stressed the importance of developing cognitive skills, social and emotional learning, problem-solving abilities, resilience and collaboration skills. This Declaration and the conference underscored education's crucial role in tackling global environmental issues and promoting sustainability (UNESCO, 2021).

Through EE and ESD, individuals are empowered to understand the complex dynamics of the environment, recognize their impact, and take action to protect and preserve it (Jimlan, 2021). EE aims to cultivate a sense of environmental responsibility and empower individuals to contribute towards sustainable development. EE aims to create a sense of environmental consciousness and encourage individuals to actively protect and preserve the environment (Mohammed & Ogar, 2023). It promotes knowledge and awareness of environmental issues, fosters a sense of interconnectedness between humans and the environment, and equips individuals with the skills and tools necessary to address environmental challenges. ESD emphasizes the need to integrate economic, environmental and social dimensions of development in all aspects of education. It aims to equip individuals with the knowledge, values, attitudes and skiils needed to address the global challenges of environmental sustainability (Nurwaqidah et al., 2019). It is based on the recognition that current development

patterns are unsustainable and that education has a essential role in shaping a more sustainable society.

When considering the relationship between EE and ESD, it is essential to recognize that both approaches share common goals and philosophies despite focusing on different areas. EE aims to instill values, ethics, and awareness for the protection and conservation of the environment while also promoting knowledge and awareness of environmental issues and fostering a sense of interconnectedness between humans and the environment (Kopnina, 2014; Lamere et al., 2022). On the other hand, Education for Sustainable Development (ESD) aims to empower learners to make informed decisions and take responsible actions that ensure environmental integrity, economic sustainability, and social justice for both current and future generations. It highlights the importance of incorporating economic, social, and environmental aspects of development into every facet of education (Kopnina, 2014). Both EE and ESD aim to cultivate individuals willing to participate in strategies regarding sustainable development (Grice, 2017).

In conclusion, EE and ESD are interconnected as they work towards instilling values, promoting knowledge and awareness, and empowering individuals to take action for a more sustainable future. Their mutual emphasis on societal and environmental improvement highlights the necessity for a collaborative and integrated educational approach to address sustainability challenges effectively (Kopnina, 2014). Through these efforts, both EE and ESD can contribute to achieving the SDGs and a more sustainable society (McBride et al., 2013).

ESD primarily aligns with SDG 4, specifically Target 4.7, which focuses on ensuring ESD and global citizenship. Additionally, ESD is connected to SDG12, notably Target 12.8, emphasizing the need for sustainable lifestyles in harmony with nature, and SDG13, Target 13.3 focuses on enhancing education, raising awareness, and building human and institutional capacity to address climate change mitigation and adaptation. (Leicht et al., 2018).

The 2030 Agenda’s SDGs must catch up at the agenda's midpoint. While there was some progress between 2015 and 2019, more was needed to achieve the goals. The COVID-19 pandemic and other concurrent crises have caused a global stall in SDG progress since 2020. High-income countries have managed to mitigate the impact of these crises through stabilizers and recovery plans. However, progress on environmental and biodiversity goals, particularly SDGs #12 Sustainable Production and Consumption, #13 Climate Action, #14 Life Below Water, and #15 Life on Land, still

needs to be made. These challenges have intensified fiscal problems in low-income and lower-middle-income countries, causing a regression in several goals and indicators. Despite these setbacks, achieving the SDGs remains attainable, underscoring the necessity for heightened commitment to these objectives (Sachs et al., 2023).

ESD is crucial in achieving the United Nations' SDGs (Li et al., 2022). Numerous studies have shown the relationship between ESD and the United Nations' SDGs. These studies highlight the importance of integrating sustainable development concepts into education at all levels, from kindergartens to universities (Milama et al., 2019). This integration can empower individuals to contribute to a more sustainable society and address global challenges such as poverty, climate change, and inequality.

2.2. Environmental Literacy

2.2.1. Definitions and Dimensions of Environmental Literacy

Over the past half-century, the definition of literacy has expanded beyond essential reading and writing skills. Today, it encompasses the ability to comprehend, make informed decisions, and take action on complex societal issues. The term now applies to various fields, such as computer, mathematics, cultural, and arts literacy. Additionally, concepts like environmental literacy (EL), ecological literacy, and eco-literacy have emerged, reflecting this broader understanding of what it means to be literate in a rapidly evolving world (McBride et al., 2013).

Environmental literacy addresses current and emerging environmental challenges (Masemene & Msezane, 2021). It involves understanding interconnected ecological systems, possessing cognitive skills to analyze and resolve environmental issues, and fostering a responsible attitude toward the environment (Durmuş & Kınacı, 2021). As educators, we must incorporate educational strategies that provide students with the knowledge and tools needed to tackle these challenges.

EL has long been a topic of considerable discussion within the EE field, characterized by a lack of a universally accepted definition and reflecting its multidimensional nature. Despite its widespread use, Disinger and Roth (1992) noted the need for a precise definition, suggesting EL as a complex and evolving concept. This view is supported by various researchers who have contributed diverse perspectives to understanding EL. For example, Rockcastle (1989) examined environmental literacy

by focusing on how humans interact with their natural environment, encompassing both biotic and abiotic elements. This conception aligns closely with the broader definition of EE proposed by Stapp (1969), indicating a strong connection between EE and EL. Conversely, Daudi (1999) primarily associated EL with cognitive aspects, particularly the ability to read and write about environmental topics, focusing on a broad scale of environmental knowledge.

The foundational definitions and frameworks of EL, established over decades, highlight its multifaceted nature. The initial work by Stapp (1969) laid the groundwork for EL understanding, which was further expanded by the Tbilisi Declaration (UNESCO, 1978). Hart (1981) contributed to this by identifying essential characteristics of Environmental Education (EE), complemented by Harvey's (1977) extensive review of EE structures.

Harvey (1977) categorized environmental literacy into three levels:

(a) An environmentally literate individual possesses essential skills, knowledge, and emotions about the human-environment relationship.
(b) An environmentally competent individual not only has environmental literacy but also can apply, analyze, synthesize, and evaluate information, has the necessary implementation skills, and holds values that align with overarching goals for the human-environment relationship.
(c) An environmentally dedicated person extends beyond literacy and competence in the affective domain, characterized by a value system that promotes consistent actions to maintain balance between quality of life and environmental quality.

Harvey's framework was one of the initial efforts to formulate and define environmental education and environmental literacy. Hungerford and colleagues, in 1980, aligned their goals for curriculum development with the objectives outlined in the Tbilisi Declaration, marking a significant step towards standardizing EL education. Roth's comprehensive framework in 1992 and Simmons' detailed analysis of 26 frameworks in 1995 further enriched the understanding of EL. The Environmental Literacy Assessment Consortium, led by Wilke in 1995, and the insightful meta-analysis of research on Environmentally Responsible Behaviors (ERB) by Hines et al. in 1986/87 and Osbaldiston in 2004 have contributed substantially to this field. Hsu, in 1997, summarized these efforts, highlighting that EL encompasses four main categories: knowledge, affect, skill, and behavior.

Over time, the scope of EL has expanded beyond mere cognitive understanding to include affective and behavioral dimensions. Schneider (1997) furthered this argument by stating that EL is not merely about being well-versed in environmental disciplines but involves a deeper, more holistic understanding and engagement with environmental issues. Coppola (1999) argued that while literacy typically concerns cognitive aspects, EL should also cover conative elements, such as behavioral changes that stem from knowledge and skills. Roth (1992) proposed an ecological paradigm for Environmental Literacy (EL), which includes the ability to perceive, interpret, and respond to the health of environmental systems. His comprehensive approach defines EL as a combination of knowledge, affect (such as attitudes, environmental sensitivity, and values), skills and behavior (including personal investment and active participation).

According to Roth (1992), there are three levels of environmental literacy, each with unique characteristics along which individuals progress toward acquiring EL (Figure 2.1).

- **Nominal Environmental Literacy**: This is the initial level of environmental literacy, marked by essential cognitive awareness and the beginning of understanding. Individuals at this level are familiar with fundamental environmental concepts and their meanings. They know the essential elements of nature, including living and non-living entities and necessities for life. They also recognize the value of both nature and society, are capable of identifying problems, and engage in behaviors that enhance environmental quality (Roth, 1992).

- **Functional Environmental Literacy**: This second level focuses on applying and transferring knowledge and specialized skills to daily life. Individuals with functional environmental literacy understand how natural systems work and the interactions between human-made social systems and natural systems. They are informed about the history of environmental issues and can analyze them from their perspective. They are capable of collaborative work, are internally motivated, and participate in individual, group, and movement activities (Roth, 1992).

- **Operational Environmental Literacy**: This is the highest level of environmental literacy. Individuals at this level possess in-depth environmental knowledge. They continually acquire information on environmental topics and convert it into responsible

environmental behaviors promoting sustainability. They utilize scientific process skills and exhibit high awareness and sensitivity towards the environment (Roth, 1992).

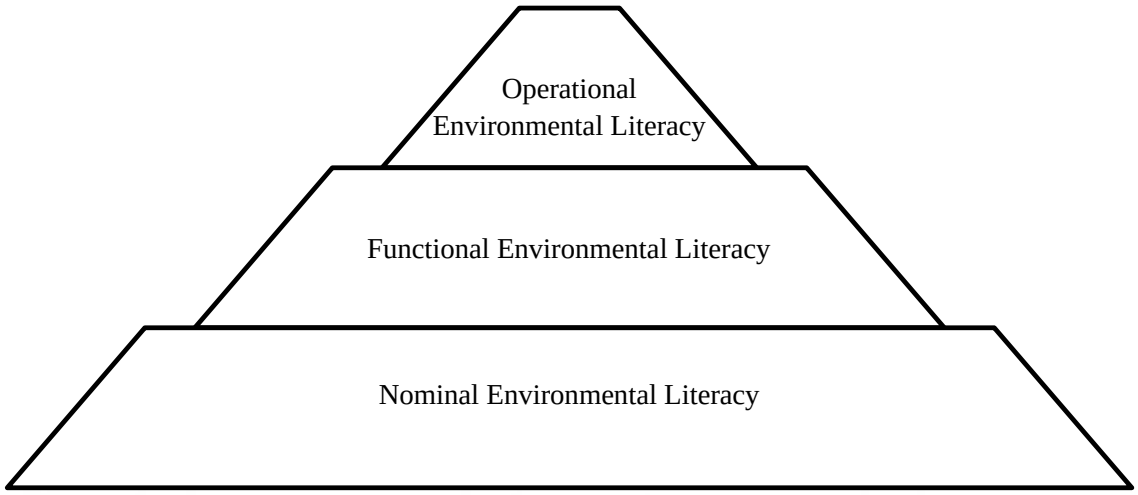

Figure 2.1. The levels of environmental literacy (Roth, 1992).

Each level represents a progressive deepening of understanding and engagement with environmental issues, from essential awareness to active and informed participation. Moseley (2000) advocated that the primary objective of environmental education should be to cultivate operational environmental literacy.

Over time, professionals have increasingly acknowledged that earlier definitions and objectives, though valuable, needed to be more constrained in their scope and depth. They often lacked the flexibility to adapt to the rapidly evolving external factors impacting the field, such as the urgent need for sustainability and responses to climate change, as well as internal developments, including new findings from research reviews. This realization has spurred the development of more comprehensive and evolving frameworks for EL.

Since the 1990s, various frameworks for environmental literacy have been introduced. These frameworks align with the objectives set by the Tbilisi Declaration (UNESCO, 1978), focusing on four key areas: knowledge (awareness and knowledge), cognitive skill (skills), affective disposition (attitudes), and behavior (participation). As Hollweg et al. (2011) pointed out, notable contributions include works by Hungerford and Volk (1990), Roth (1992), Simmons (1995), and Wilke (1995). Post-1995, these frameworks have played a pivotal role in guiding research reviews, such as those by Volk and McBeth (1997), in the creation of assessment tools (Wilke, 1995), and in conducting various national evaluations of EL, exemplified by studies from Negev et al. (2008), Erdoğan (2009), and

Shin et al. (2005). The theoretical framework presented by Simmons (1995) played a crucial role in shaping the development of the National Guidelines for Excellence Project initiated by the North American Association for Environmental Education (NAAEE) in 2010 (NAAEE, 2010).

In conclusion, the definitions of EL have evolved significantly, transitioning from a narrow focus on environmental knowledge to a more inclusive understanding that integrates knowledge, attitudes, skills, and behaviors. This evolution mirrors the growing recognition of the complexity of environmental challenges and underscores the need for a holistic approach to developing an environmentally literate and responsible citizenry.

2.2.2. The Components of Environmental Literacy

The development of EL can be best understood through distinct stages, which are most effectively identified by observing behavior (Moseley, 2000). Hungerford and Peyton (1977) conceptualized environmental literacy as a multifaceted concept that encompasses individuals' ability to comprehend environmental issues and effectively communicate and execute strategies aimed at environmental remediation. This comprehensive view highlights that environmentally literate individuals are characterized by their knowledge, skills, and willingness to engage in meaningful actions to address environmental challenges.

Hollweg et al. (2011) developed a framework for environmental literacy (EL), partly for use in the Programme for International Student Assessment (PISA). Like Roth (1992), EL is organized into four domains or components: knowledge, affective dispositions, skills, and behavior. The framework characterizes an environmentally literate individual as someone who collaborates with others to make decisions regarding the environment, actively implements these decisions to improve local, national, and global environments, and participates in civic life (Hollweg et al., 2011). According to Hollweg et al. (2011), environmental literacy entails acquiring (A) knowledge of environmental concepts (five knowledge components), (B) affective attitudes (five dispositions), (C) cognitive skills (seven competences), and (D) behavioral competencies (multiple modes). Assessing all these components and contexts would require an impractical amount of time. Therefore, developers of both international and national environmental literacy assessments must choose specific components to focus on early in the assessment framework development process. Figure 2.2. displays the elements chosen for the NELA project (McBeth et al., 2008, 2011). Additionally, it emphasizes the interrelatedness and feedback mechanisms among these components.

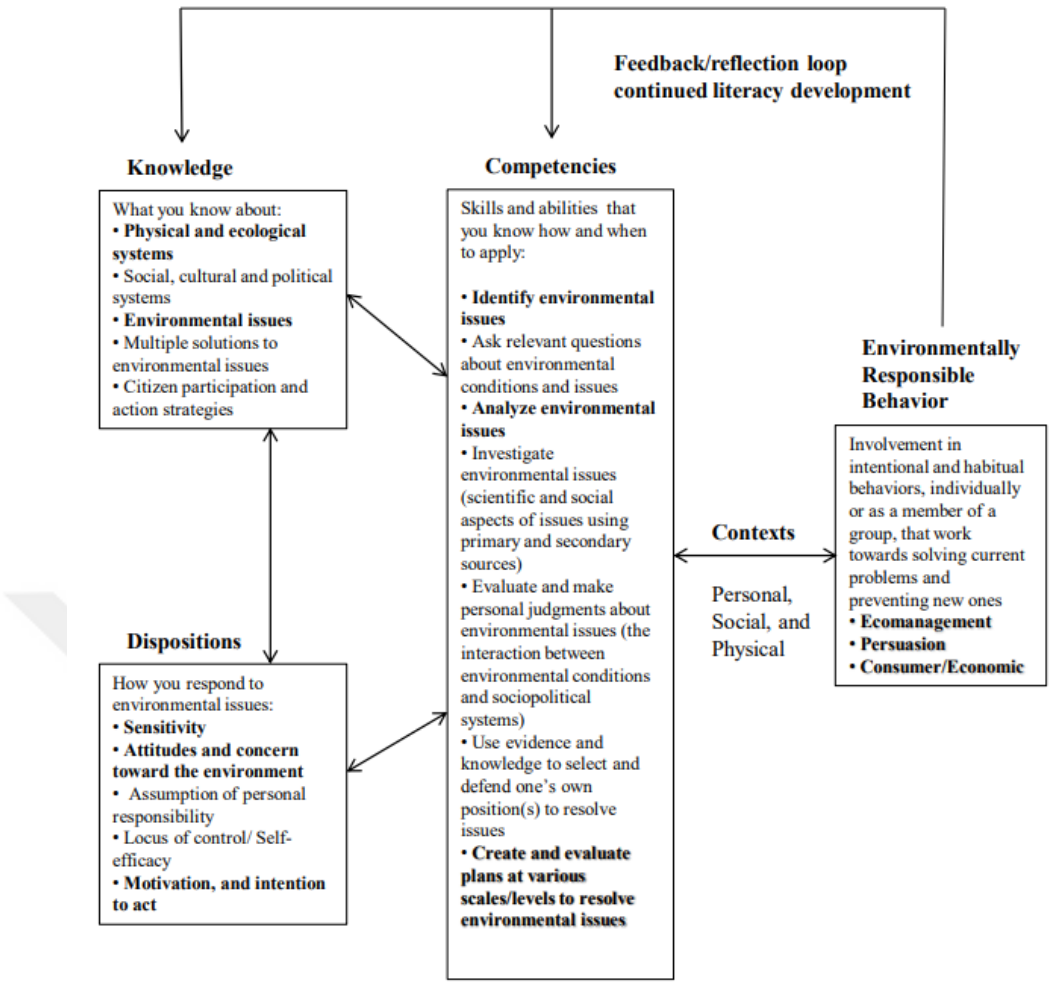

Figure 2.2. Elements of environmental literacy evaluated in the National Environmental Literacy Assessment Project.

Central to environmental literacy is the component of *environmental knowledge*. This includes an individual's understanding of ecological behavior and factual information, such as insights into ecological concepts and awareness of various environmental problems and issues, as outlined by Hines et al. (1986/87). Expanding on this, Gambro and Switzky (1994) emphasized that environmental knowledge also involves comprehending and assessing the impacts of societal actions on ecosystems. Environmental knowledge encompasses an understanding of ecological systems, environmental history, contemporary environmental challenges, and socio-political-economic dimensions. Such a holistic understanding underscores the importance of linking human activities with ecological outcomes, aligning with current interdisciplinary approaches in environmental education. The significance of environmental knowledge extends beyond theoretical understanding; it is also a crucial predictor of responsible environmental behavior, as studies have consistently shown a correlation between environmental knowledge and demographic attributes like age, gender, income,

and educational background. Research indicates that younger individuals, females, and those with higher income and education levels tend to report more excellent environmentally responsible behavior (ERB) (Dopelt et al., 2021).

Another critical environmental literacy component is *affective disposition*, which refers to an individual's attitudes and emotions toward the environment. It comprises subcomponents such as environmental sensitivity, locus of control, intention to act, environmental attitude, and environmental responsibility. Research has shown that environmental knowledge significantly influences affective disposition (Dopelt et al., 2021).

Additionally, *cognitive skills* play a crucial role in environmental literacy. These skills, which stem from a solid foundation in environmental knowledge, are essential for critically analyzing ecological problems and devising effective solutions. They enable a deeper understanding of environmental issues, empower individuals to develop strategic solutions, and take responsibility for conservation efforts (Lin & Xiu-Juan, 2016; Sabet et al., 2021). Promoting environmental literacy, particularly cognitive skills, is vital for enabling individuals to contribute to environmental conservation actively. Integrating environmental education into curricula and fostering a comprehensive understanding of ecological systems and issues is critical for developing the knowledge, attitudes, and skills necessary for active environmental stewardship (Görmüş, 2019). Moseley (2000) suggested that while understanding and awareness of environmental issues are crucial, environmental education must also incorporate problem-solving skills to foster environmentally responsible behavior. Problem-solving involves a cognitive process that encourages students to address and analyze a problem to find a solution. This skill offers numerous benefits, including training individuals to collaborate systematically, fostering creativity, enhancing cognitive processes, boosting intellectual capabilities, increasing personal motivation, and promoting active engagement in the learning process (Eliyasni et al., 2019). Moseley (2000) emphasized that achieving environmentally responsible behavior is equivalent to reaching environmental literacy, which he views as the highest aim of environmental education. McBride et al. (2013) suggested incorporating problem-solving projects as examples of strategies used in environmental literacy education.

Finally, as defined by Sivek and Hungerford (1989/1990), *environmentally responsible behavior* encompasses advocating for the sustainable use of natural resources or reducing consumption. This behavior can be categorized into various forms, such as civic, educational, financial, legal, and physical actions (Smith-Sebasto & D'Acasto, 1995). This detailed categorization reflects the

increasing emphasis in recent literature on diverse approaches to environmental stewardship. Building on this, Morrone et al. (2001) emphasized that truly environmentally literate individuals can combine knowledge and values into actionable behavior. Hsu (1997) aligned with this perspective, understanding that the willingness to engage in environmental issues often stems from a person's intrinsic motivation to assume personal responsibility for environmental initiatives.

In conclusion, environmental literacy is a comprehensive construct integrating various components—environmental knowledge, affective disposition, cognitive skills, and environmentally responsible behavior. Each component is critical in fostering a well-rounded understanding of and engagement with environmental issues. The ultimate goal of environmental education, as emphasized by Roth (1992) and Stapp (1969), is to develop individuals who are not only environmentally literate but also actively engaged in promoting and participating in sustainable practices and behaviors, as also highlighted by Hungerford and Peyton (1977). By fostering these components, environmental education programs can effectively equip individuals with the necessary tools to address and mitigate environmental challenges.

2.2.3. Conceptual Framework of Environmentally Responsible Behavior

Initial studies and conventional beliefs posited that a greater understanding of environmental issues naturally leads to more responsible actions toward environmental conservation and problem-solving (Alıcı, 2019). However, subsequent inquiries into environmental behavior challenged this straightforward correlation (Hungerford & Volk, 1990). Notably, Kibert's research (2000) indicated that the link between knowledge and actual behavioral change is not as significant as previously thought, suggesting that merely increasing knowledge is insufficient for altering behaviors. Moseley (2000) suggests that individuals who are knowledgeable about the environment and actively participate in resolving environmental issues can be considered environmentally literate. As described by Kışoğlu et al. (2010), environmental behavior is a concrete expression of an individual's environmental knowledge, skills, and attitudes, characterized by active involvement in activities aimed at addressing and resolving environmental issues. This aligns with the goals of environmental education, as set out at the Tbilisi Conference, to cultivate individuals who demonstrate responsible environmental behaviors.

The Tbilisi Conference (UNESCO, 1978) highlighted behavior change as a critical objective of environmental education. During the conference, governments concurred that a primary goal of

environmental education is to foster new behavior patterns among individuals, groups, and society at large about the environment. Drawing on the goals set at the Tbilisi Conference, Hungerford and Volk (1990, p.9) described environmentally responsible citizens as those who possess:

(1) an awareness and sensitivity to the total environment and its allied problems [and/or issues],
(2) a basic understanding of the environment and its allied problems [and/or issues],
(3) feeling of concern for the environment and motivation for actively participating in environmental improvement and protection,
(4) skills for identifying and solving environmental problems [and/or issues], and
(5) active involvement at all levels in working toward resolution of environmental problems [and/or issues].

Environmentally responsible behavior (ERB) encompasses applying knowledge, attitudes, and skills in various contexts and is a foundation for ongoing learning and new behaviors. In environmental education and related fields, terms like environmental behavior, ecological behavior, and pro-environmental behavior are used interchangeably to describe actions aimed at positively impacting the environment. These behaviors target environmental problems and can lead to positive environmental outcomes (Stern, 2000).

Researchers have studied various variables related to environmentally responsible behavior (ERB). Hines, Hungerford, and Tomera (1986/87) conducted a meta-analysis with 128 studies examining these variables and used their findings to develop a model for ERB. The analysis undertaken by Hines et al. (1986/87) identified several factors influencing environmentally responsible behavior (ERB). They analyzed fifteen distinct variables and grouped them into four categories based on their relation to ERB. These categories included (1) cognitive variables, (2) psycho-social variables, (3) demographic variables, and (4) a group consisting of experimental studies that included behavioral interventions and classroom tactics designed to promote ERB. Based on the results of their meta-analysis of 128 studies, Hines and colleagues developed a model of responsible environmental behavior, which is depicted in Figure 2.3.

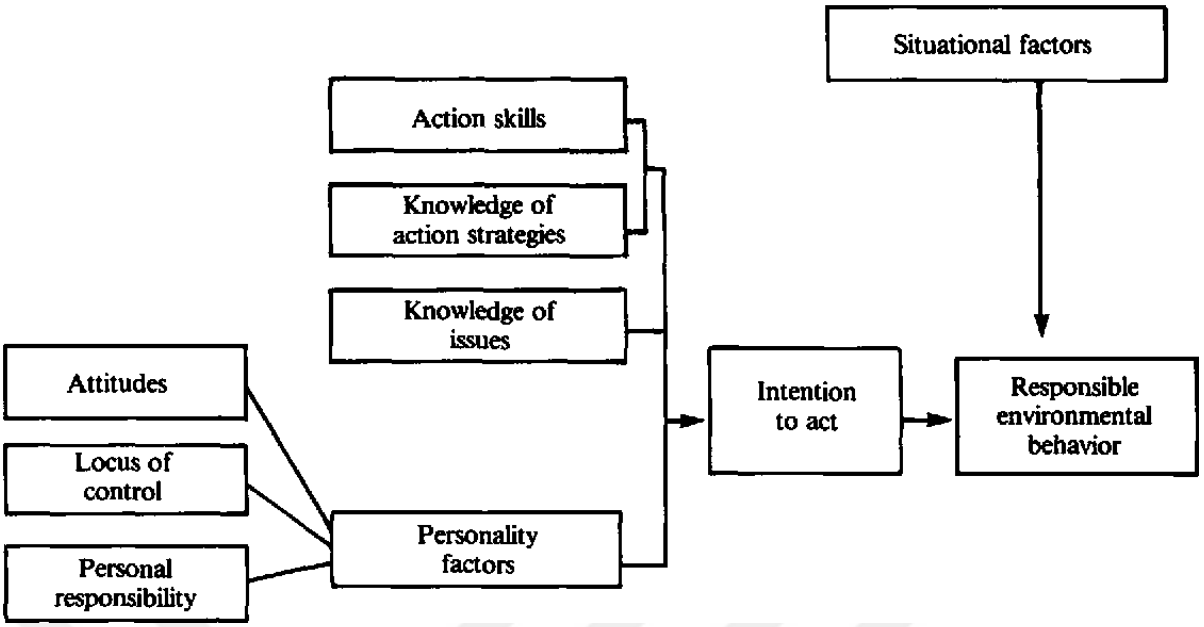

Figure 2.3. The proposed model of responsible environmental behavior (Hines et al., 1986/87, p. 7).

Various other models have been created to explore the factors influencing environmentally responsible behavior (ERB):

- A conceptual framework that adheres to the intention-and-consequence standard and has been applied in extensive assessments is a categorization of citizen action modes developed by Peyton and Hungerford (Hungerford & Peyton, 1980; Hollweg et al., 2011). These behaviors are categorized into Eco-Management (direct actions to solve or prevent environmental problems), Consumer/Economic Action (actions involving monetary support or financial pressure to address environmental issues), Individual and Public Persuasion (efforts to persuade or warn about environmental issues), Political Action (involves any form of action aimed at exerting pressure on political or governmental entities and individuals to encourage them to adopt positive environmental measures) and Legal Action (supporting or proposing new laws to resolve environmental challenges) as outlined by Hsu (1997), Volk & McBeth (1997), and Erdoğan (2009). The use of these five categories to assess ERB and report estimates of validity and reliability has been conducted by several researchers (Sivek & Hungerford, 1989/90; Marcinkowski, 2001). These categories appear robust enough to serve as the basis for measures of ERB at the elementary, secondary, and adult levels.

- Stern (2000) presented another framework for ERB, focusing on environmental activism, non-activist behaviors in both public and private spheres, and other significant environmental actions. Beyond Hungerford and Peyton's and Stern's approaches, various other methods exist for conceptualizing and assessing ERB. These are employed in studies such as MSELS and NELA Phase One and Phase Two (McBeth et al., 2008, 2011).
- A third conceptualization emphasizes action competence, civic engagement, and collaborative problem-solving (Hollweg et al., 2011).

Nearly two decades later, Bamberg and Möser (2007) replicated and expanded upon Hines et al.'s study, conducting their meta-analysis on this evolving research field. Bamberg and Möser (2007) explored the psycho-social factors that influence pro-environmental behavior by analyzing 57 samples and employing structural equation modeling to assess the relationships among eight determinants. Their findings revealed that the intention to perform pro-environmental behavior is a mediator for the impact of all psycho-social variables on actual behavior. The study underscored that personal moral norms, attitude, and behavioral control are vital predictors of pro-environmental intentions. Additionally, it highlighted that problem awareness is a critical indirect determinant influenced by moral and social norms, guilt, and attribution processes. The research underscored the complexity of the factors affecting pro-environmental behavior and the significant roles played by personal moral norms and intentions.

2.2.4. Studies Related to Environmental Literacy and Environmentally Responsible Behavior

A comprehensive content analysis of 53 research studies on environmental literacy conducted in Turkey between 1997 and 2007 revealed significant insights and identified critical gaps in the field (Erdoğan et al., 2009). The analysis focused on students' knowledge of ecology, environmental problems, natural history, and their affective dispositions toward the environment. Researchers collected data on students' understanding of ecosystems, biotic and abiotic factors, food chains, and global and national environmental issues such as global warming, pollution, recycling, and waste management. Attitudinal attributes in these studies included general and specific effects, such as attitudes toward waste management, ecological environments, and endangered species. However, the study highlighted several neglected areas in environmental literacy research in Turkey. Notably, socio-political-economic knowledge, cognitive skills, and environmentally responsible behavior received limited attention in the selected studies.

The study by Kışoğlu et al. (2010) conducted a comprehensive content analysis of environmental literacy research in Turkey between 1999 and 2009. They examined 71 studies, including master's theses, doctoral dissertations, and articles. The study focused on understanding this period's scope, trends, and gaps in environmental literacy research. Their review encompassed studies focusing on the population's ecological knowledge, attitudes, and behaviors, revealing that while there is a general interest in environmental issues, the overall level of environmental literacy remains suboptimal. The study points out that environmental education in Turkey has not been wholly effective in enhancing understanding and engagement with environmental matters. Much of the research was limited to assessing knowledge and attitudes, with less emphasis on developing skills and behaviors for environmental responsibility.

The Delphi study on environmental literacy conducted by Kaya and Elster (2019) aimed to define and explore the dimensions and competencies of environmental literacy. The study identified the importance of knowledge and understanding of environmental issues, attitudes and concerns towards the environment, morals and ethics related to the environment, intention to act with environmentally responsible behavior, and skills to evaluate data and draw conclusions as essential components of environmental literacy. The study also underscored the importance of incorporating environmental perceptions, examples of environmentally friendly behavior, and social perspectives into curricula and textbooks to promote environmental literacy.

Kışoğlu et al.'s study (2010) calls for research that addresses environmental literacy through different educational stages and in informal education settings, highlighting the importance of practical application and real-life engagement with environmental issues. Kaya's (2019) study concluded that integrating socio-scientific texts and activities into science education positively impacted students' scientific and environmental literacy levels, fostering critical thinking skills and environmental awareness among 7th-grade students. This indicates that a more holistic approach to environmental education, which includes practical applications and socio-scientific issues, can significantly enhance environmental literacy.

In the current study, waste and waste management were chosen as the main issues for the intervention program. Waste management encompasses complex environmental, economic, and social dimensions involving scientific and social elements. Social factors, including consumption habits, environmental awareness, financial conditions, political structures, and technological advancements, shape waste management strategies, policies, and practices. Additionally, solutions to

waste issues often require community involvement and are influenced by social factors such as education levels, public participation, and cultural values. Therefore, waste is an environmental issue and a significant social topic.

By integrating the findings from Kışoğlu et al. (2010), Kaya and Elster (2019), and Kaya (2019), this study underscores the need for comprehensive environmental education programs that incorporate socio-scientific issues like waste management. These programs should enhance students' environmental literacy by developing their knowledge, attitudes, skills, and behaviors through practical applications and real-life engagement with environmental issues.

The study conducted by Akçadağ and Çobanoğlu (2018) aimed to investigate the impact of outdoor education on 7th-grade students' environmental literacy regarding the "Human and Environment" unit. A quasi-experimental design was employed with a control group taught using traditional methods and an experimental group taught through outdoor activities. Pre and post-tests were conducted using the Elementary School Environmental Literacy Instrument (ESELI) to assess students' environmental knowledge, affective dispositions towards the environment, environmentally responsible behaviors, and cognitive skills on environmental protection. The findings indicated significant improvements in the experimental group's affective dispositions towards the environment and cognitive skills related to environmental protection compared to the control group. However, no statistically significant difference was observed in environmental knowledge between the groups. Overall, the study highlights the positive impact of outdoor education on students' environmental attitudes and cognitive skills, emphasizing the importance of experiential learning in fostering environmental literacy.

Öney (2022) conducted a study to evaluate the content of master's and doctoral theses on environmental literacy and foresee upcoming developments in this area. Meta-synthesis, a qualitative research approach, was applied to amalgamate existing studies on environmental literacy. Twenty-four accessible master's and doctoral theses related to environmental literacy from the YÖKTEZ database were surveyed, with nine meeting the inclusion criteria (five master's and four doctoral), published between 2009 and 2020. Results indicated that higher education students and teacher candidates were frequently selected as participants; structured interview forms were commonly used for data collection; student-centered activities influenced most approaches to environmental education. However, courses explicitly focusing on the environment had a more significant impact on enhancing levels of environmental literacy. Researchers are recommended to use open-ended

questions, semi-structured interview questions, or individuals' drawings associated with the research topic in their data collection techniques to assess environmental literacy levels within the sample group, allowing individuals to express their views more openly. Accordingly, it may be beneficial for researchers conducting studies on environmental literature to employ diverse designs for their research structure based on an extensive survey of the literature. Uygun and Karabulut (2023) analyzed postgraduate national theses on environmental literacy between 2012-2022. The study includes 41 theses, mainly at the master's level, predominantly in science fields mentioned in Öney's (2022) study, using quantitative methods. It suggests an increased interest in environmental literacy in recent years, with a need for more doctoral research and diverse methodologies. It recommends expanding data collection tools to deepen understanding of environmental literacy education. Timur et al. (2014) conducted a study to examine articles, master's theses, and doctoral theses published between 1992 and 2011 in Turkey and worldwide regarding environmental literacy and to identify the general trends in these studies. A total of 44 domestic and foreign articles, six master's theses, and five doctoral theses were included in the analysis, which examined factors such as publication year, sample, research design, data collection techniques, and results obtained from experimental studies. It was discovered that the individuals most favored for study purposes comprised students pursuing higher education or aspiring to become teachers. It was observed that only eight studies within the sample were experimental research, and most of these were deemed adequate. The study suggests that future researchers focus on preschool as a sample group, prefer different research methods, and utilize open-ended or semi-structured interview questions for data collection, as these approaches were found to be less frequently used in the existing literature.

Following the recommendations by Öney (2022) and Timur et al. (2014), this doctoral research utilized semi-structured interviews to allow for more in-depth responses, aligning with contemporary methodological trends highlighted by Uygun and Karabulut (2023). Additionally, middle school students were included as participants to assess environmental literacy within this key educational demographic, enhancing the findings' robustness and relevance.

Güler (2013) sought to assess the environmental literacy levels of 8th-grade students and analyze the impact of various factors on these levels. The study included 182 students from five primary schools in Saimbeyli, Adana, utilizing a survey model and a detailed "Environmental Literacy Survey." The results indicated that students had moderate environmental knowledge and responsible behaviors, high affective tendencies, and low cognitive skills. The study also revealed low-level yet

significant positive correlations between knowledge and affective tendencies and between knowledge and skills.

Özsoy et al. (2012) explored how eco-schools affect elementary school students' environmental literacy by comparing those attending eco-schools with students from traditional schools. The eco-school program was shown to positively influence students' environmental knowledge, attitudes, and behaviors, suggesting that it can enhance their environmental literacy. The study highlighted the crucial role of effective environmental education in schools and the benefits of eco-school initiatives in fostering environmental literacy among elementary students. It emphasized the need for further studies to examine the factors influencing environmental literacy and to extend the time frame for researching the long-term retention of environmental literacy and its impact on attitudes and behaviors.

Uyar and Kazu (2018) utilized a quasi-experimental design to investigate the impact of computer-aided environmental education on students enrolled in the Computer Technologies program. The study involved 60 second-grade students at a vocational school. Thirty students were assigned to a control group and thirty to an experimental group within the Computer Technologies program. The control group received traditional environmental education, while the experimental group used computer-aided methods. Post-tests revealed significant improvements in environmental literacy for both groups, indicating that receiving environmental education increased students' knowledge, behavior, and perception. The findings of this study suggest that incorporating computer-aided methods into environmental education programs can positively impact students' environmental literacy. The impact of environmental education conducted using student-centered learning methods, such as research project-based or collaborative learning, on students' environmental literacy levels can be investigated. Computer-assisted environmental education positively influenced students' environmental literacy, including animations, short films, documentaries, and educational films. In this dissertation, animations, short films, and project-based learning were incorporated to explore further and enhance the effectiveness of environmental education on students' literacy.

Studies by Nunez and Clores (2017), Yazgan (2023), and Negev et al. (2008) highlight critical insights into the need for fostering environmentally responsible behavior (ERB) among students through improved environmental literacy. Nunez and Clores (2017) examined K-10 students in the Philippines and found that while students had moderate environmental knowledge and behavior, their attitudes and sensitivity were high. Crucially, the study noted that environmental knowledge did not

always lead to positive environmental behaviors, indicating a gap that needs addressing. They identified three key dimensions of environmental literacy: environmental attitudes and sensitivity, environmental knowledge, and pro-environmental behaviors, emphasizing the need for curricula beyond knowledge to foster behaviors actively. Similarly, Yazgan (2023) analyzed changes in environmental literacy within science education over several years, finding that primary students' understanding of the environment remained insufficient while knowledge components were frequently included. The study suggested that environmental education needs a stronger focus on developing skills and active engagement in environmental issues. It also highlighted that students in international assessments like PISA and TIMSS struggle due to a lack of higher-level cognitive skills, indicating problems translating curriculum goals into effective learning outcomes. Adding to these findings, Negev et al. (2008) assessed the environmental literacy of Israeli sixth-grade and twelfth-grade students through a national survey, revealing no significant correlation between environmental knowledge and behavior. They also examined the influence of ethnic and socioeconomic factors on environmental literacy. The study found that environmental education objectives in Israel have yet to be fully achieved and suggested improved educational strategies to bridge the gap between knowledge and behavior. It highlighted the need for further research to understand how environmental education can translate knowledge into responsible environmental behavior more effectively and recommended integrating environmental ethics into the curriculum. Together, these studies underscore the pressing need for curricula integrating knowledge, attitudes, skills, and behaviors to enhance environmental literacy and foster environmentally responsible behaviors. The current research considers this holistic approach, essential for students to understand environmental issues and actively engage in and address them.

Derman et al. (2016) explored outdoor education’s impact on the environmental literacy of pre-service classroom teachers. They used an experimental design with control and experimental groups. Traditional teaching methods were employed in the control group, while the experimental group engaged in active, outdoor-based learning. Results showed significant improvements in the experimental group's environmental attitudes, uses, and concerns, indicating that outdoor education can effectively enhance environmental literacy. The study suggests that incorporating outdoor education into teacher training programs can be beneficial in developing environmentally literate educators.

The study by Coyle (2005) evaluated environmental literacy in America, primarily focusing on the NEETF/Roper research and related studies spanning a decade. The key findings indicate a general

need for deep environmental knowledge among Americans despite widespread environmental awareness. The report emphasizes the need for more effective environmental education and literacy, highlighting the gap between awareness and understanding of complex environmental issues. It calls for a more integrated approach to environmental education to foster a scientifically informed citizenry that engages with environmental challenges.

The study by Garcesa and Limjuco (2014) examined environmental literacy and the incorporation of environmental issues among science teachers. The research involved 400 science teachers from various public secondary schools. It aimed to investigate the relationship between their environmental literacy levels and their integration of environmental issues into the science curriculum. The study found that, although teachers possessed a high level of environmental knowledge, their pro-environmental behavior was comparatively lower, indicating a disparity between knowledge and action. This gap underscored the need for enhanced training and support for teachers to integrate environmental education effectively. The research highlighted the need to understand how teachers' environmental literacy translates into their teaching practices. It called for more in-depth studies on teachers' obstacles when incorporating environmental education into their curriculum and the effectiveness of different support mechanisms to overcome these challenges. Additionally, exploring the impact of teacher training programs on improving both environmental literacy and the ability to teach environmental concepts effectively would be beneficial.

Chu et al. (2006) and Mahmoudi (2021) provide critical insights into the development and effectiveness of environmental literacy through various educational programs. Chu et al. (2006) investigated environmental literacy among Korean students across different grades using the Environmental Literacy Instrument for Korean Students (ELIKS). Their findings indicated that while there were no significant differences in environmental literacy scores across grades, there were notable correlations between different aspects of environmental literacy. The study highlighted the impact of gender, parental educational background, and pre-experience in environmental education programs on environmental literacy, with these influences diminishing as students aged. Importantly, the study found that environmental attitudes had a stronger correlation with behaviors than environmental knowledge did, underscoring the importance of fostering positive attitudes for responsible environmental behavior. This emphasizes the need for varied teaching materials, strategies, and opportunities for active participation in environmental programs to improve environmental literacy, especially as students mature.

Similarly, Mahmoudi (2021) conducted a meta-analysis of 35 studies in Iran, evaluating the effectiveness of environmental education programs on environmental literacy. The analysis revealed that these programs were more effective for older age groups, particularly in shaping environmental behavior and attitudes. Mahmoudi's study also highlighted the need for tailored environmental education programs to maximize effectiveness across different age groups.

Additionally, the study pointed out a significant gap in understanding the long-term impacts of these programs on sustained environmental literacy and behavior change, calling for further research to explore these aspects over time and in diverse cultural settings. Both studies underscore the complexity of enhancing environmental literacy and the necessity of comprehensive, age-appropriate educational strategies. They highlight the importance of attitudes in fostering environmentally responsible behavior and the need for ongoing research to identify the most effective components of environmental education programs for lasting impacts. The current research takes these findings into account, emphasizing the development of holistic and adaptive educational frameworks to improve environmental literacy and promote sustained responsible behavior among students.

Erdoğan's (2009) study evaluated the EL of 5th-grade students in Turkey. In the study, a total of 2,412 fifth-grade students from 26 provinces in Turkey participated. The sample selection involved a multi-stage sampling procedure, ensuring representation from rural and urban areas within these provinces. It considered six components of EL to determine the level of environmentally responsible behaviors (ERB) among these students. The study used a nationwide survey, including a specially developed instrument for data collection, and applied various statistical analyses to assess the students' EL. The research primarily targeted a specific age group in a particular national context. It pointed to a need for similar studies across different age groups and in varied cultural and geographical contexts. New studies could provide a more comprehensive understanding of how environmental literacy develops across different stages of education and in diverse environments. Additionally, the study's focus on ERB suggests a potential research gap in exploring the long-term impacts of these behaviors and their sustainability over time.

Takyi et al. (2023) conducted a study assessing environmental literacy among 354 high school students in Kumasi (Ghana), focusing on behavior, attitudes, sensitivity, and cognitive skills. The findings indicate that students generally exhibit a moderate level of environmental literacy. Notably, male students showed higher knowledge, affect, and cognitive abilities compared to female students, while younger students demonstrated more pro-environmental behavior than older ones. The study

identifies challenges like limited nature exposure and inadequate resources, suggesting that enhancing environmental literacy requires more than just school curricula. It emphasizes the need for comprehensive programs and extracurricular activities, such as TV and environmental projects, to foster effective environmental education.

The study by Wardani et al. (2018) analyzes the environmental literacy of 65 high school students, focusing on knowledge, attitude, and concern. The methodology included a pre-test and post-test design. The results indicated that 80% of students had inadequate environmental literacy, signifying a medium level of environmental attitudes. The study highlights the need for more comprehensive and valuable environmental education in schools to enhance student's understanding and engagement with environmental issues.

The study by Nastouas (2017) focused on assessing the environmental literacy levels of middle school students in Thessaloniki, Greece. The study utilized the Middle School Environmental Literacy Survey (MSELS), translated into Greek, and involved 200 students aged between 13 and 15 years. Critical areas examined include ecological knowledge, environmental behavior, issue identification and analysis, and action planning. The study offered essential insights into how middle school students in Greece understand and engage with environmental concepts. It highlights their current knowledge, attitudes, and behaviors related to environmental issues. The study also pointed out potential areas where environmental education in Greece could be improved to improve students' environmental literacy. This study opens avenues for further research into the effectiveness of environmental education curriculum in different cultural contexts and their impact on various age groups. Longitudinal studies tracking environmental literacy from middle school through higher education levels could provide valuable insights into the long-term effectiveness of such educational programs. Svobodová and Kroufek (2022) also focused on assessing the environmental literacy of middle school students but in the Czech Republic and Slovakia. They employed the modified MSELS across 436 students from both countries. The study revealed that environmental literacy is moderately related to affective and behavioral dimensions but weakly connected to cognitive aspects. Nastoulas et al. (2017) also found similar results by using MSELS. In the Czech and Slovak contexts, the study finds that the cognitive aspect of environmental literacy does not significantly impact its affective (attitude) or behavioral components. However, there is a moderate correlation between the affective and behavioral dimensions, supporting the findings of researchers like Heimlich and Ardoin (2008), Bamberg and Möser (2007), and Hines et al. (1986/87), who noted the influence of attitudes on behavior. Age is a significant factor in shaping attitudes, behaviors, and sensitivity towards the

environment, with these aspects tending to decrease as age increases, a trend was also observed with grade levels. This negative correlation between age and the affective dimension of environmental literacy aligns with findings by researchers like Nastoulas et al. (2017) and Stevenson et al. (2014).

Additionally, younger students in lower grades demonstrated higher scores in attitudes and sensitivity, as noted in the National Environmental Literacy Project in the USA (McBeth et al., 2011; McBeth & Volk, 2009). Gender, grade, leisure activities, and age significantly influence environmental literacy. The research concludes that extracurricular activities should complement environmental education in schools to change students' pro-environmental behavior effectively.

2.3. Project-Based Learning

2.3.1. Definitions and Design Principles of Project-Based Learning

Project-based learning (PjBL) is an educational approach that encompasses learning through projects where students engage in design, problem-solving, decision-making, or investigations. This method allows students to work independently for extended durations and results in the creation of tangible products or presentations (Thomas, 2000). PjBL is an instructional strategy emphasizing active participation through project completion, aimed at boosting student motivation and cognitive skills, as described by Maulana et al. (2019).

The origins of PjBL can be traced back to the early 1900s, with John Dewey, the father of progressive education, emphasizing the importance of learners actively engaging in the learning process. This concept, known as "learning by doing" or "student-directed learning," laid the foundation for PjBL.

The related literature describes different forms and characteristics of Project-Based Learning (PjBL). Thomas (2000) defines PjBL as "a model that organizes learning around projects" (p.1), describing projects as "complex tasks, based on challenging questions or problems, involving students in design, problem-solving, decision-making, or investigative activities; allowing students to work relatively autonomously over extended periods of time; and culminating in realistic products or presentations" (ibid).

Fried-Booth (2002) views PjBL as "student-centered and driven by the need to create an end-product. However, it is the route to achieving this end-product that brings opportunities for students to develop their confidence and independence and to work together in a real-world environment" (p.6). Similarly, Markham et al. (2003) describe PjBL as "a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed projects and tasks" (p. 4).

Researchers have identified several essential components or characteristics of PjBL due to the absence of a universally accepted definition (Uçar, 2024). These components include:

- **Student-centered:** Projects are designed around student interests and needs (Diffily, 2002; Simpson, 2011; Metin & Aral, 2014).
- **Driving question:** Projects incorporate a central question or issue that guides the learning process (Simpson, 2011; Curtis, 2002).
- **Practical applications:** Projects result in a product or presentation with real-world applications (Sumarni, 2013).
- **Final product:** Students produce a final tangible product (Diffily, 2002; Stoller, 2006).
- **Real-life problems:** Projects address real-life issues (Thomas, 2000; Diffily, 2002).
- **Process and product-oriented:** Projects focus on the process and the end product (Stoller, 2006).
- **Problem-solving:** Students develop products to address problems as part of learning (Köse, 2010; Sumarni, 2013).
- **Collaboration:** Students work together within a limited timeframe to achieve specific goals (Vasiliene-Vasiliauskiene et al., 2020).
- **Cooperative learning:** Projects encourage a collaborative rather than competitive learning environment (Simpson, 2011).
- **Multidisciplinary approach:** Projects combine various disciplines to address interdisciplinary issues (Butvilas et al., 2016; Sumarni, 2013; Diffily, 2002).
- **Knowledge building:** Students identify concerns, explore perspectives, gather and assess information (Blumenfeld et al., 1991), and develop knowledge (Köse, 2010).

According to Thomas (2000), a project must meet five fundamental criteria to be classified as an example of PjBL:

1. **Centrality:** Projects are integral to the curriculum, serving as the primary content learning and assessment method. The centrality criterion implies that projects where students learn material outside the standard curriculum, like "enrichment" projects, are not considered true PjBL despite being engaging and appealing.
2. **Driving question:** Projects revolve around critical questions or problems that engage students with core concepts and principles. Driving questions should be connected to the content, increase student engagement, and encourage active intellectual problem-solving.
3. **Constructive investigations:** Projects involve students constructing and transforming knowledge, leading to final outputs like presentations, reports, inventions, or models. If students can complete the tasks with pre-existing knowledge or skills, the project is merely an exercise, not a PjBL project. Therefore, PjBL projects should assist students in identifying problems, developing and designing solutions, and creating final outputs such as presentations, reports, inventions, or models.
4. **Autonomy:** Students significantly drive projects. Unlike traditional instruction, PjBL projects have no predetermined outcomes or follow set paths. Instead, they promote students' self-management skills, such as time management and making choices.
5. **Realism:** Projects are based on real-world challenges and efforts to solve them rather than purely academic tasks.

Grant (2002) examined the theoretical foundations of project-based learning and identified seven key elements through various implementation examples. These elements highlight standard features of PjBL:

- **Introduction:** Projects often begin with an introduction that "sets the stage" and motivates learners.
- **Task:** The task or driving question outlines what needs to be accomplished and includes the study content.
- **Resources:** Various resources provide the necessary data for the project.
- **Process:** The process involves the steps required to complete the task or answer the driving question.
- **Guidance and scaffolding:** As students work on their projects, they will need support in the form of guidance and scaffolding.
- **Cooperative/collaborative learning:** Many projects involve group work, especially where resources are limited.

- **Reflection:** Effective PjBL projects offer opportunities for closure and reflection. This can include follow-up questions and in-class discussions that help students consolidate their learning.

Krajcik and Blumenfeld (2005) identified five essential features of the Project-Based Learning (PjBL) environment based on various studies (e.g., Blumenfeld et al., 1991; Krajcik et al., 2002).

These key features include:

- **Driving questions:** PjBL initiates a compelling problem that students must address. This approach sparks curiosity and motivates students to engage deeply with the subject matter, promoting critical thinking and problem-solving skills.
- **Situated inquiry:** Students participate in authentic and contextual inquiry processes, which are critical for mastering expert performance in a specific field. Engaging in real-world scenarios helps students better grasp and apply essential concepts, thereby bridging the gap between theoretical knowledge and practical application.
- **Collaboration:** The inquiry process in PjBL emphasizes collaboration among students, teachers, and community members. This collective effort to find solutions to problems reflects the social complexity of real-world problem-solving, fostering teamwork, communication skills, and the ability to view issues from multiple perspectives. Collaborative projects also help students build interpersonal skills and learn the value of diverse viewpoints.
- **Learning technologies:** Integrating learning technologies in PjBL supports students' inquiry processes and allows them to engage in activities beyond their current skill levels. These technologies provide access to a wealth of information, research and analysis tools, and communication and collaboration platforms, enhancing the overall learning experience.
- **Artifacts:** Students create tangible products that address the driving questions and represent their learning publicly. These artifacts demonstrate students' understanding and application of knowledge and provide a means for assessment and reflection. Producing artifacts helps students develop a sense of ownership and pride in their work, and sharing these products with a broader audience can enhance their communication and presentation skills.

Ravitz (2010) broadly defined and operationalized his project-based learning approach to accommodate varying levels of teacher participation while recognizing the existence of a more stringent version. The fundamental principles Ravitz (2010) outlined:

- **In-depth inquiry:** Emphasizing comprehensive investigation and exploration of topics.
- **Extended duration:** Projects are carried out over a significant period.
- **Student autonomy:** Students have a degree of self-direction in their learning process.
- **Formal presentation:** Students formally present their results.

The Buck Institute for Education (BIE) updated its initial eight essential elements of PjBL to better align with current educational standards and practices (Larmer & Mergendoller, 2015). These updates were made to ensure that the design of PjBL projects adheres to what BIE terms the "gold standard" of PjBL (Figure 2.4). According to BIE, incorporating these elements into project design is crucial for achieving high-quality PjBL implementation (Buck Institute for Education, 2015).

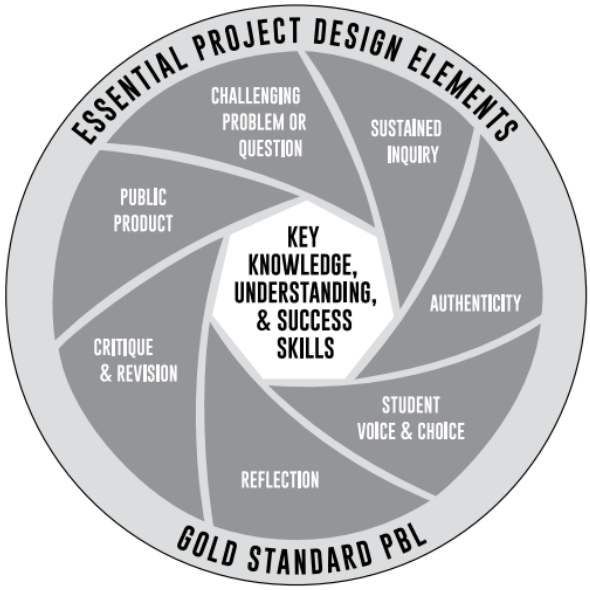

Figure 2.4. Gold standards of project-based learning (Buck Institute for Education, 2015, p.1.).

- **Essential knowledge, understanding, and success skills:** The project aims to teach students critical knowledge and understanding based on educational standards, as well as skills (e.g., problem-solving, self-management).
- **Challenging problem or question:** The project revolves around a significant problem to solve or a question to answer, appropriate for the student's level, articulated through an open-ended, engaging, driving question.
- **Sustained inquiry:** The project involves an ongoing, in-depth process where students generate questions, utilize resources, ask additional questions, and formulate their answers over time.

- **Authenticity:** The project is set in a real-world context, utilizing real-world processes, tools, and standards. It makes a tangible impact and/or connects to students' personal interests, concerns, and identities.
- **Student voice and choice:** The project empowers students to make choices about their work products, methods, and time management under teacher guidance, tailored to their age and experience with PjBL.
- **Reflection:** The project includes opportunities for students to reflect on their learning process, the project's design, and its implementation.
- **Critique and revision:** The project incorporates processes for students to receive and provide feedback, enabling them to revise their ideas and products or pursue further inquiry.
- **Public product:** The project requires students to showcase their learning through a product presented or delivered to an audience beyond the classroom.

2.3.2. Benefits of Project-Based Learning

John Dewey stressed that high-quality and continuous experiences are crucial for effective learning. Initially, PjBL was predominantly used in foreign language education, health, and engineering fields. Over time, it has been recognized for its numerous benefits across various disciplines:

- **Increases Motivation and Self-Esteem:** PjBL significantly boosts students' motivation and self-esteem by involving them in their learning and encouraging the creation of high-quality work (Blumenfeld et al., 1991; Elam & Nesbit, 2012). In this context, students educated through PjBL tend to be more successful and exhibit higher motivation than those who receive traditional instructional methods (Sumarni, 2013).
- **Enhances Academic Achievement:** PjBL has been found to enhance academic performance effectively (Chen & Yang, 2019; Erdem, 2012; Kılınç et al., 2022; Yavuz, 2016). Studies show it improves academic achievement and learner autonomy (Pichailuck & Luksaneeyanawin, 2017).
- **Promotes Collaboration and Teamwork:** PjBL fosters cooperation and teamwork by engaging students in group projects, enhancing skills such as active listening, creativity, and respect for others (Bell, 2010; Elam & Nesbit, 2012). Research in various educational contexts has shown that PjBL improves communication and collaboration skills (Bani-Hamad & Abdullah, 2019; Giri, 2016).

- **Improves Higher-Order Thinking and Problem-Solving Skills:** PjBL situates student engagement at the core of culturally responsive curricula, sparking a passion for solving real-world problems. It develops skills like critical thinking, problem-solving, decision-making, and initiative (Bell, 2010; Eliyasni et al., 2019; Prananda et al., 2020; Sumarni, 2013).
- **Enhances Communication Skills:** Through PjBL, students gain research, team organization, and communication skills by explaining their ideas and convincing others, which enhances their social and 21st-century skills (Bani-Hamad & Abdullah, 2019; Bell, 2010; Giri, 2016).
- **Enhances Positive Attitudes Towards Learning:** PjBL is effective in fostering positive attitudes toward learning (Erdem, 2012; Holm, 2011), increasing attendance, and enhancing students' overall success (Thomas, 2000).
- **Reduces Anxiety:** PjBL decreases students' anxiety levels by increasing their engagement and passion for the subject matter, making the learning process less stressful (Erdem, 2012; Sumarni, 2013).
- **Promotes Interdisciplinary Knowledge:** PjBL fosters a multidisciplinary approach, providing a contextual and constructivist learning environment that integrates various disciplines and enhances understanding (Bell, 2010; Blumenfeld et al., 1991; Capraro & Jones, 2013).
- **Improves Critical and Analytical Thinking:** PjBL enhances critical and analytical thinking skills by engaging students in inquiry and challenge-based learning (Capraro & Jones, 2013).

Despite the benefits associated with PjBL, there are numerous challenges in its implementation (Sumarni, 2013):

- PjBL requires significant time to solve complex problems, potentially leading to insufficient time to cover essential content.
- Some parents may feel burdened by the additional costs of transitioning to a new educational system.
- Many instructors may need help shifting from traditional teaching methods, in which they play a central role in the classroom, to the more facilitative role required by PjBL.
- Implementing PBL can be intimidating for both experienced and novice teachers.
- The need for additional equipment in PjBL classrooms can increase demands for resources like electricity.
- Students**,** particularly those with weaknesses in experimental skills and information gathering**,** may face challenges in PjBL settings.

- Implementing PjBL in large classes may create difficulties in engaging all students effectively in the PBL process (Blumenfeld et al., 1991)

The researcher, demonstrating a proactive approach, considered some of these challenges when designing and implementing PjBL in the Packaging Waste Recovery Education Program (PWREP) in educational settings. For example, the group size was organized to accommodate 19 students, a manageable number for effective facilitation. Since the implementation is after school, time is organized better than in-class hours, optimizing the learning experience. Communication with parents was limited since the school was boarding, but efforts were made to ensure their involvement.

2.3.3. Project-Based Learning in Environmental Education and Environmental Literacy

The constructivist learning approach can utilize teaching methods like project-based learning, inquiry-based learning, cooperative learning, problem-based learning, computer-assisted learning, and the 3E, 5E and 7E learning cycles. Similarly, the active learning model can be implemented using various instructional methods such as cooperative learning techniques, mind maps, research-based teaching, discovery learning, and the case method (Arık & Yılmaz, 2020). Reflecting this resemblance, it is notable that employing a constructivist learning approach and active learning models in environmental education is essential, as outlined in foundational documents such as the Tbilisi Declaration.

The Tbilisi Declaration, a fundamental document in environmental education, highlights (UNESCO, 1978):

- **Awareness:** Enhancing sensitivity and consciousness about environmental challenges.
- **Knowledge:** Promoting a fundamental comprehension of environmental issues.
- **Attitudes:** Cultivating concern for the environment and inspiring active engagement in its protection.
- **Skills:** Developing abilities to identify and address environmental problems.
- **Participation:** Fostering direct involvement in tackling environmental issues at different levels.

The Tbilisi Declaration’s core aims and principles align seamlessly with the objectives of the constructivist learning approach and active learning models (Arık & Yılmaz, 2020). Building upon

these principles, Education for Sustainable Development (ESD) strives to empower individuals to become proactive and thoughtful citizens who embrace sustainability and adopt sustainable lifestyles. This is achieved through cultivating knowledge, attitudes, values, and behaviors across the three pillars of sustainable development: environmental, economic, and social aspects. ESD is designed to be learner-focused, action-driven, and transformative (Leicht et al., 2018).

The study run by Arık and Yılmaz (2020) aimed to assess the impact of constructivist and active learning approaches on environmental education, contrasting these with traditional learning methods in their research. Integrating data from 57 national and international studies between 2000 and 2015. The findings revealed that constructivist learning, and active learning methods significantly and positively influenced environmental education. The study advocates for a more robust integration of these methods in environmental education curricula, underscoring their profound impact on learning outcomes. Notably, the study indicates that smaller class sizes, ideally not exceeding 50 students, and program durations between 7 and 12 weeks are optimal for maximizing the effectiveness of these educational methods. The duration and size of the student group in the *Packaging Waste Recovery Education Program (PWREP)* developed and implemented by the research were considered.

Transitioning from these broader educational principles to specific methodologies, project-based learning (PjBL) enables students to explore real-world environmental challenges. As Waluyati et al. (2023) suggest, this approach allows students to apply their knowledge meaningfully and cultivates collaboration, critical thinking, problem-solving abilities, and personal environmental responsibility. Benzer and Şahin (2013) focused on the impact of project-based learning on undergraduate students' environmental problem-solving skills. The results indicated a significant improvement in problem-solving skills among students who underwent project-based learning compared to those who received traditional instruction. Yavuz (2016) conducted a study that presents a comprehensive content analysis of master's and doctoral theses related to PjBL in science education in Turkey. This study undertook a content analysis of these theses from 2002 to 2014, examining 32 master’s and 11 doctoral theses. Researchers primarily assessed whether implementing PBL in the classroom improved students’ academic performance and attitudes toward learning science. Research gaps suggested by the study include investigating the impact of PjBL on other areas, such as critical thinking skills, problem-solving abilities, creativity, collaboration, engagement, motivation, and knowledge retention. This broader approach can lead to more nuanced insights and recommendations for educators and policymakers looking to enhance the effectiveness of PjBL practices in the classroom. Genç (2015) emphasized the significance of hands-on, experiential learning through

projects to enhance students' understanding of environmental issues and foster a sense of responsibility towards the environment. The research indicates that project-based learning in environmental education leads to increased student engagement, more profound comprehension of environmental concepts, and the development of critical thinking and problem-solving skills. By actively participating in projects related to environmental issues, students are more likely to retain knowledge, apply it in real-world scenarios, and become environmentally conscious individuals.

Boncukçu (2020) examined the impact of utilizing the Problem-Based Learning Model in teaching Sustainable Development to 8th-grade students. A pretest-posttest control group design was used, with an experimental group being taught using PjBL and a control group following a regular science education curriculum for Sustainable Development. Results indicated that implementing PjBL improved students' environmental attitudes and problem-solving abilities while preventing increased test anxiety. The study concluded that the PjBL Model effectively promotes students' interest, critical thinking skills, and learning outcomes in Geography, Science, Chemistry, and Sustainable Development (Permatasari et al., 2019). Additionally, the PjBL model enhances students' problem-solving, scientific process, critical thinking, and creativity skills. Kaya and Elster's (2019) findings emphasized the significance of using effective teaching methods, such as project-based learning and collaborative approaches, to foster the development of environmentally literate individuals. To maximize the effects of the *Packaging Waste Recovery Education Program* (PWREP) developed and implemented by the researcher on students' environmental literacy level, which includes problem-solving skills and environmentally responsible behavior as subdimensions, project-based learning was chosen in the current study as a teaching method.

In line with these findings, Derevenskaia (2014) studied the application of active learning methods in environmental education, specifically through project-based learning. The research was conducted with school students, focusing on assessing the ecological conditions of the river Kazanka. The study highlights the effectiveness of project-based learning in enhancing students' understanding of ecology and biology, developing practical skills, and fostering a sense of responsibility towards the environment.

Kılınç et al. (2022) evaluated PjBL in science education through a mixed-meta method, analyzing 34 national studies to determine PjBL's effectiveness. The meta-analysis of the studies revealed a positive effect size value, indicating a significant positive impact of PjBL on students' academic success in science education. The study concluded that PjBL in science education positively

affects learners' academic achievement, attitude, and various aspects, emphasizing the importance of active learning and student engagement in promoting meaningful learning experiences.

Zengin and Yucasu (2017) focused on the effectiveness of project-based learning on the environmental literacy of preservice science teachers. The study aimed to explore how implementing PjBL could influence the knowledge and behaviors of teacher candidates regarding environmental issues. The researchers provided the preservice teachers with guidance on various stages of project development, including topic selection, hypothesis formation, research methods, data collection, analysis, and presentation. The researchers conducted an orientation training on virtual classroom features for the teacher candidates before engaging them in PjBL activities. Key findings from the study indicated that the PjBL approach positively impacted the environmental literacy of the preservice science teachers. By engaging in project development and virtual classroom activities, the teacher candidates were likely better equipped to address environmental issues and contribute to developing environmentally conscious students in the future.

Holm (2011) conducted a comprehensive review of the effectiveness of project-based instruction in educational settings ranging from preschool to 12th- grade, covering the period from 2000 to 2011. Holm's methodology involved an extensive literature search through education-related databases, focusing on peer-reviewed articles in English. This resulted in the identification and analysis of 17 articles related to the effectiveness of PjBL in classroom settings. The review found that: a) project-based learning was generally more effective than traditional lecture-based instruction. Students in PjBL settings exhibited more significant gains in content knowledge and skills related to the learning process. This effectiveness was observed across various educational levels and subjects. b) Holm (2011) observed that PjBL positively affected student attitudes toward learning. Students in PjBL environments reported greater engagement and enjoyment in learning and improved perceptions of the subject matter. This suggests that PjBL enhances academic outcomes and positively influences students' attitudes toward learning and self-perception. c) In preschool settings, PjBL was more effective than traditional methods in promoting language and concept development. d) Studies indicated that PjBL was particularly beneficial for diverse learners, including those who might not excel in traditional academic settings. e) The success of PjBL was linked to specific teacher attributes, such as effective classroom management, solid content knowledge, and the ability to support students as needed. This finding suggests that the effectiveness of PjBL may also depend on the quality of teaching and the environment in which it is implemented.

Holm (2011) concludes that project-based instruction is a highly effective educational method that offers benefits over traditional lecture-based instruction. The research indicates that PjBL leads to improved content learning, higher levels of student engagement, more positive perceptions of subject matter, and the development of robust problem-solving strategies. The review underscores the potential of PjBL to engage students deeply and personally in the learning process, making it a valuable approach in modern education. This review reinforces the efficacy of project-based learning across various educational levels and settings. It highlights the importance of teaching skills and classroom environment in maximizing the benefits of PjBL, pointing toward a need for focused teacher training and supportive educational policies to implement PjBL effectively. The findings also suggest that PjBL can be particularly advantageous for students who might not thrive under traditional educational methods, offering a more inclusive and engaging learning experience.

In conclusion, this review highlights the significant role of PjBL in enhancing environmental education and literacy, emphasizing active participation and real-life problem-solving (Holm, 2011). However, challenges such as integration into standard curricula and the need for flexible teaching methods remain. Future research should focus on the long-term impact of these methods, their scalability in different educational settings, and the role of teacher training for effective implementation, which emphasizes the need for a holistic approach in environmental education, combining traditional and innovative teaching methods to enhance students' environmental literacy and active participation in addressing ecological challenges.

2.4. Circular Economy and Waste Management

Globally, the extraction of materials has seen a significant increase: it has grown more than threefold since 1970 and nearly doubled since 2000, now amounting to 100 billion tons. Projections indicate that in 2050, material extraction and usage could double compared to levels in 2015. Meanwhile, yearly waste production is anticipated to rise by 70% by 2050 (World Bank, 2018). This escalation poses a serious risk to the planet's life support systems, which are already nearing their limits (Circle Economy, 2023). The existing economic model is significantly breaching the Earth’s environmental safety thresholds. Five out of the nine crucial ‘planetary boundaries,’ which track the health of our land, oceans, and atmosphere, have been exceeded, primarily due to the effects of the linear ‘take-make-waste’ economy. Thus, changing how we interact with materials is essential, aiming to optimize benefits for humanity while reducing the strain on the Earth’s vital ecosystems (Circle Economy, 2023).

In contrast to the traditional linear economy, which follows a ‘take-make-consume-dispose’ pattern, the circular economy implemented since 2015 is centered around concepts like sharing, leasing, reusing, repairing, refurbishing, and recycling (European Commission, 2020). A circular economy creates a nearly self-contained system where the value of products and their materials is maximized, and waste is minimized. Adopting a circular economy offers several benefits, including less environmental strain, more secure raw material supplies, increased competitiveness, innovation, economic growth, and job creation. However, transitioning to this model (Figure 2.5) also presents challenges, such as the need for financing, critical economic drivers, skill development, changes in consumer behavior and business models, and governance at multiple levels (European Commission, 2020).

Figure 2.5. Circular economy model.

Currently, the world’s economy operates with merely 7.2% circularity, and this figure is deteriorating annually due to increasing material extraction and usage. Conversely, by adopting a circular economy model, the global community can meet people's needs using only 70% of the materials presently consumed, staying within the Earth's environmental safety boundaries (Circle Economy, 2023).

A fundamental shift is needed from the traditional ‘produce-consume-dispose’ linear economy approach to a ‘reduce-reuse-recycle- recovery-redesign-remake’ approach characteristic of a circular economy (Sharma et al., 2021). This regenerative and restorative shift positively influences SDGs 1, 3, 6-9, 11, and 13-15. The circular economy represents a significant structural transformation that aims for long-term resilience by optimizing the use and circulation of goods, resources, and nutrients, in line with SDG 12. This approach offers environmental, economic and social advantages, aligning

with SDGs 1, 2, 9, 13-15, and supports both immediate and long-range goals of the SDGs. Implementing circular economy principles in Solid Waste Management is crucial in fostering sustainable development's three pillars: social inclusion, economic growth, and environmental protection (Ellen MacArthur Foundation, 2020).

SDG 12, one of the 17 goals, promotes "responsible consumption and production" to uncoupling economic development from environmental degradation and the overuse of natural resources. The SDGs serve as a guiding framework for realizing a more sustainable and improved future for everyone. SDG 12's key targets include implementing the 10-Year Framework of Programs on Sustainable Consumption and Production (SCP), effectively managing and utilizing natural resources, reducing different types of waste, and managing waste and chemicals responsibly (Chan et al., 2018). It also emphasizes that businesses and public procurement processes need to adopt sustainable practices. The global economy heavily depends on consumption and production, which is almost entirely responsible for environmental damage and health issues (Chan et al., 2018).

In 2008, the Waste Framework Directive 2008/98/E.C., passed by the European Parliament, incorporated the waste hierarchy principle (European Parliament, 2008). This directive was later integrated into the laws of European Union (E.U.) member countries. The Waste Framework Directive establishes a prioritized sequence for waste management. The Circular Economy Strategy, introduced by the European Commission in 2015 through EU COM/2015/0614, emphasized the importance of a waste hierarchy-based approach in waste management (European Commission, 2015). This approach leads to the most favorable environmental outcomes and helps reintegrate valuable materials into the economy. In 2016, the concept of the waste hierarchy was integrated into the 2030 Agenda for Sustainable Development, which was adopted by 193 United Nations member countries. SDG 12 aims to substantially decrease waste generation by 2030 through prevention, reduction, recycling, and reuse (Pires & Martinho, 2019).

In 2020, the European Union Commission implemented the circular economy action plan, a vital component of the European Green Deal (E.U. Commission, 2020). This initiative targets achieving climate neutrality for the European Union by 2050. The action plan outlines strategies to foster a circular economy. These include establishing sustainable products as a standard within the European Union and concentrating on resource-intensive sectors with a high potential for circular practices. Key focus areas are electronics and I.T., batteries and vehicles, packaging, plastics, textiles, and the

construction and building sector and industries dealing with food, water, and nutrients (PlasticsEurope, 2023).

The volume of materials used in packaging has been steadily increasing, and in 2017, packaging waste in Europe reached an unprecedented high of 173 kg per person (European Commission, 2020). To achieve the goal of making all packaging in the European Union (E.U.) market reusable or recyclable in a cost-effective manner by 2030, the European Commission plans to revise Directive 94/62/E.C. 27. This revision will strengthen the mandatory requirements for packaging to be accepted in the E.U. market. It will explore additional measures focusing on Minimizing excessive packaging and waste from packaging, potentially through setting targets and implementing other measures to prevent waste. Encouraging designs that facilitate the reuse and recycling of packaging may include restrictions on using certain packaging materials for specific uses, especially when there are viable reusable alternatives or when consumer products can be safely handled without packaging. Looking at simplifying packaging materials, such as reducing the variety of materials and polymers used (European Commission, 2020).

In 2022, worldwide plastic production amounted to 400.3 million tons. Of this, Europe contributed 58.7 million tons (PlasticsEurope, 2023). This surge in production can be attributed to the widespread adoption of plastics across various economic sectors, with the packaging and food industries being the primary consumers of these materials. Tackling unsustainable consumption and production patterns necessitates a systematic approach bolstered by collaboration among actors in the supply chain and initiatives to raise awareness and provide education (Reisch et al., 2016).

It is essential to monitor consumption patterns, consumer behavior, and lifestyles. Schools have a significant part to play in educating about sustainable development, and there is a need for more research into ongoing learning about sustainable lifestyles and consumption (Chan et al., 2018). ESD is essential to accomplishing the United Nations' SDGs (Li et al., 2022). Milama et al. (2019) underscores the necessity of incorporating principles of sustainable development into educational curricula across all stages, from kindergarten to university. Embedding these concepts in education equips people with the skills and knowledge to build a more sustainable society and tackle worldwide issues like climate change, hunger and inequality.

2.4.1. Waste Management and Packaging Waste

There are some keywords in the field of waste, such as rubbish, waste, municipal waste, waste management, prevention, and waste hierarchy.

Waste is "any substance or object which the holder discards or intends or is required to discard" (European Parliament & Council of the European Union, 2008, p.3). Waste and rubbish are close but different terms. "Rubbish" refers to materials unsuitable for recycling that must be landfilled or disposed of properly. On the other hand, "waste" is produced due to consumption and, through recycling and recovery processes, can be turned into a material that sometimes holds economic value (Kumtepe, 2023).

Municipal waste means (European Parliament & Council of the European Union, 2008, p.3-4)

- "mixed waste and separately collected waste from households, including paper and cardboard, glass, metals, plastics, bio waste, wood, textiles, packaging, waste electrical and electronic equipment, waste batteries and accumulators, and bulky waste, including mattresses and furniture
- mixed waste and separately collected waste from other sources, similar in nature and composition to household waste".

Waste management refers to the entire process of handling waste, which includes collecting, transporting, sorting, recovering, and disposing of waste. This process also encompasses the supervision of these activities, the maintenance of disposal sites, and any actions carried out by waste dealers or brokers (European Parliament & Council of the European Union, 2008).

- The term "collection" in this context refers explicitly to gathering waste. It includes initial sorting and temporary waste storage in preparation for transportation to a facility where it will be treated further.
- "Separate collection" is a more specific term that describes a method of waste collection where different types of waste, such as paper, cardboard, and plastic, can be kept separate based on their characteristics. This separation ensures that each type of waste receives the most appropriate treatment.

The waste hierarchy concept has been integrated into international and national legislative frameworks and regulations for waste management (Pires & Martinho, 2019). In 2008, the E.U.'s

Waste Framework Directive 2008/98/E.C. (WFD) established the waste hierarchy, mandating it as the core principle for waste management in E.U. countries. According to the Waste Framework Directive (European Parliament & Council of the European Union, 2008, Article 4), in legislation and policy concerning waste prevention and management, the following order of priority, known as the waste hierarchy, is recommended:

(a) prevention;

(b) preparing for reuse;

(c) recycling;

(d) other recovery, e.g., energy recovery; and

(e) disposal

The terms in the waste hierarchy are explained as follows (European Parliament & Council of the European Union, 2008, p.5-6):

“**prevention**" is "measures taken before a substance, material or product has become waste**"**

"Preparing for reuse' is defined as "checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be reused without any other pre-processing";

“**recycling**" is "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes."

“**recovery**" is "any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfill a particular function, or waste being prepared to fulfill that function, in the plant or the wider economy."

Recovery is a broad concept that encompasses recycling and reuse.

‘**disposal’** is defined as "any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy."

The linear flow of resources in traditional systems often leads to the loss of recoverable resources, exacerbating natural resource depletion and environmental damage. The European Commission's Waste Framework Directive 2008/98/E.C. (WFD2008) introduces a 'waste hierarchy' to tackle this issue. However, ambiguities still need to be clarified to understand the WFD2008's waste hierarchy. The confusion mainly arises due to overlapping terms like 'prevention' and 'reduction,' or 'preparing for reuse' and 'reuse,' and the inclusion of 'reuse' in the 2008 definition of 'prevention' (Gharfalkar et al., 2015). Waste prevention is ideally defined as avoiding, reducing, and reusing waste at the source, excluding off-site recycling. Nonetheless, the Waste Framework

Directive, particularly in Article 3 clauses 12-13, describes prevention as actions taken before a substance becomes waste (Zorpas et al., 2014). The exclusion of 'recovery' and 'reuse' from the WFD2008 'waste hierarchy' diminishes its effectiveness as a tool for resource efficiency. Because of the need for more clarity in the WFD2008, 'waste hierarchy' challenges decision-makers in identifying and addressing inefficiencies in their operations and supply chains (Gharfalkar et al., 2015).

The EU's 2015 Circular Economy Strategy further endorsed waste management based on this hierarchy, emphasizing its environmental benefits and role in reintroducing valuable materials into the economy. The circular economy (CE) model, focusing on the principles of reduction, reuse, and recycling, aims to minimize environmental degradation by implementing these practices throughout production and consumption (Singh et al., 2020). The goal is to minimize waste throughout the production chain to consumption while fostering economic growth by conserving natural resources (Yang et al., 2014). Within the CE framework, waste is seen as a resource, emphasizing waste recovery and recycling to enhance resource efficiency and environmental benefits. The importance of waste management is growing, particularly for municipalities and researchers. In 2016, the United Nations incorporated the waste hierarchy into its 12th Sustainable Development Goal (SDG), which emphasizes responsible consumption and production. This goal aims to significantly reduce waste generation by 2030 through prevention, reduction, recycling, and reuse.

The concept of minimizing waste impacts in terms of environmental effects by reducing waste quantity, reusing waste as a resource, and recycling is referred to as the 3R approach, standing for reduce, reuse, and recycle (Muhammed et al., 2014, as cited in Kumtepe, 2023). In the current study, the researcher focused on waste hierarchy, mainly prevention, reduction, and recovery related to SDG 12, including the 3Rs. Since there is no waste after the prevention and reduction stages, the researcher should have mentioned it in the scales. Still, they are introduced in the educational program developed by the researcher.

While the EU has seen an increase in overall waste generation, the amount of municipal waste being landfilled has significantly decreased. From 1995 to 2021, municipal waste landfilled in the E.U. dropped from 121 million tonnes (286 kg per person) to 54 million tonnes (121 kg per person), a reduction of 67 million tonnes or 55%. As a result, the E.U.'s landfilling rate (the proportion of generated waste that is landfilled) fell from 61% in 1995 to under 23% in 2021. This decline is partially credited to the enactment of EU legislation, such as Directive 62/1994, which focuses on packaging and packaging waste (Eurostat, 2023a). Moreover, waste incineration in the E.U. has also

steadily risen during this period, although less significant than recycling and composting. Since 1995, the volume of municipal waste incinerated has increased 106% in 2021. Consequently, per capita municipal waste incineration has increased from 70 kg to 138 kg. The European Commission's adoption of the Circular Economy Package, which includes revised waste legislative proposals, aims to increase recycling targets for municipal and packaging waste and reduce the amount of municipal waste sent to landfills (Eurostat, 2023a).

Packaging is one of the municipal waste (European Parliament & Council of the European Union, 2008). According to Solid Waste Regulation (2015, 4a) in Turkey, the packaging is all products, including non-recyclable products, made of any material used for transporting, protecting, storing, and offering for sale, from raw materials to processed products, during the delivery of a product from the producer to the user or consumer whereas 'packaging waste' means "any packaging or packaging material covered by the definition of waste in Directive 75/442/EEC, excluding production residue" (European Parliament & Council of the European Union, 2015, p.6).

Packaging waste is one of the significant contributors to the ongoing climate crisis (Ajwani-Ramchandani et al., 2021). The existing food system, which includes production, transportation, processing, packaging, and consumption, sustains most of the world's population and over a billion livelihoods (IPCC, 2019). This system, which has seen a boom in agricultural productivity since the 1960s, plays a dual role in climate change: it is both a key contributor and increasingly susceptible to its impacts. The food system is responsible for approximately 21–37% of the world's total greenhouse gas emissions, stemming from various stages, including agriculture, land use, and the entire supply chain from storage to consumption. While eliminating food loss and waste may not be achievable, adopting effective prevention and management strategies for food waste is crucial (IPCC, 2019). Hence, the present study studied prevention, reduction, and recovery related to SDG 12.

In 2021, the European Union estimated a production of 188.7 kilograms of packaging waste per person, with significant variation across countries, ranging from 73.8 kg per person in Croatia to 246.1 kg in Ireland. The most common types of packaging waste were paper and cardboard (40.3%), plastic (19.0%), glass (18.5%), wood (17.1%), and metal (4.9%) (Eurostat, 2023b). From 2010 to 2021, there was a significant increase in the total volume of packaging waste in the E.U., a 24.2% increase. In 2021 alone, there was an increase of 6.0% from the previous year. This rise was primarily due to a significant increase in wood packaging waste, which grew by 2.3 million tonnes (19.0%). Paper and cardboard packaging also saw an increase of 1.3 million tonnes (3.9%) compared to 2020

(Eurostat, 2023b). Over these 11 years, paper and cardboard remained the predominant packaging waste, contributing 34.0 million tonnes in 2021, a 23.5% increase since 2010. Plastic packaging was the second-largest, marking a 29.9% increase from 2010. Glass packaging waste was recorded at an 18.1% increase, wood at 32.7%, and metal packaging at 10.6% in 2021 (Eurostat, 2023b).

Recent societal concern about ocean and landfill waste has spurred action, as seen in the growing impact of distressing images of packaging waste harming marine life and natural environments. This awareness has increased demands from non governmental organizations, activists, and citizen groups for corporate and governmental responsibility in addressing packaging waste issues (Ajwani-Ramchandani et al., 2021). Governments are also intensifying legal measures to hold companies accountable for the waste produced by their products. However, as Ajwani-Ramchandani et al. (2021) highlight, corporations, especially in less regulated countries, still need more motivation to alter their current practices despite these growing pressures from various stakeholders.

In Turkey, waste management has become a major national concern due to the harmful effects of rapid industrialization, urbanization, and population growth. Although the Ministry of Environment and Urbanization has established waste regulations and action plans aligned with E.U. directives to manage waste levels, the rates of waste prevention, reduction, reuse, and recycling are still low. As a result, the waste disposal rate remains high (Buzkan & Erman, 2020). Waste prevention is crucial for effective waste management, significantly impacting landfill issues and resource conservation. Currently, around 90% of municipal waste in Turkey is disposed of in landfills, with only a minor portion being recycled (as shown in Figure 2.6). In 2016, merely 9% of municipal waste underwent separate collection. Turkey should implement a thorough policy for material resources to enhance waste management and encourage the separate collection of municipal solid waste (OECD, 2019).

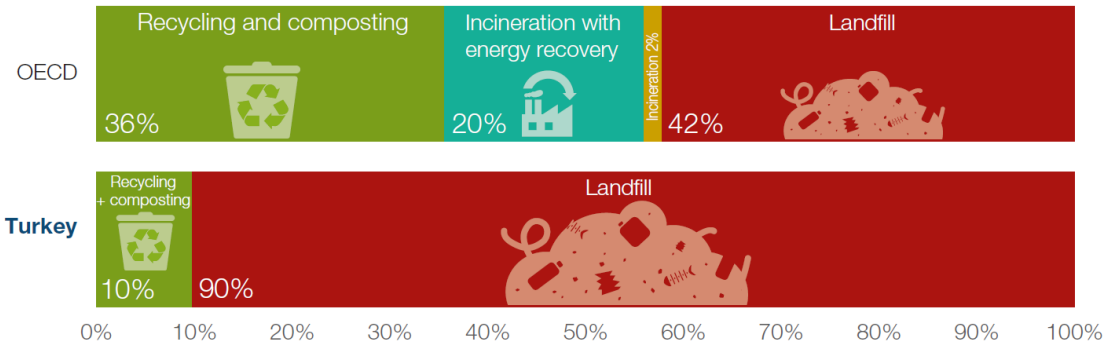

Figure 2.6. Municipal waste disposal in OECD and Turkey (OECD, 2019, p.5).

While the average recycling rate among Organisation for Economic Cooperation and Development (OECD) countries is 36%, Turkey's recycling rate is only 10% (OECD, 2019). In Turkey, solid waste management faces several critical challenges, including financial and technical support deficiencies, lack of information regarding local administration, shortages in resources, personnel, and vehicles, inadequate staff training, and insufficient public awareness about environmental protection (Ayçin & Kayapınar Kaya, 2021).

However, much progress must be made to reach its full potential. Historically, the focus has been on technological solutions to reduce waste production. While these advancements have helped conserve resources and lessen environmental harm, waste levels continue to rise. One key factor is individuals' limited and ineffective involvement in waste management strategies (Bortoleto et al., 2012). More importance should be placed on improving waste management practices in Turkey, including comprehensive policies, investments in human resources, increased recycling and separate waste collection, and greater individual involvement. This situation reflects a broader understanding that waste management is not just a technological or policy challenge but also a societal one, requiring engagement and behavior change at the individual level.

2.4.2. Educational Studies Related to Waste and Waste Management

The initial phase of educational responses focusing on environmental issues began with nature conservation education in the late 19th century. It was followed by the second phase in the 1960s, known as environmental education, and this period emphasized cultivating ecological awareness and influencing behaviors and lifestyles to be more environmentally friendly. During this era, characterized by the rise of new environmentalism and heightened concerns over pollution, waste, and waste treatment, educational initiatives aimed to enhance awareness and alter practices concerning waste management (Jamison, 2001).

A comprehensive review of both international and national studies is presented in the section. It highlights a significant gap in educational research, particularly in packaging waste. Therefore, the chapter will detail research focused on understanding the knowledge and perceptions of middle and secondary school students regarding solid waste and its management.

The “Emergent Environmentalism” project, led by Palmer and colleagues, involving 40 researchers across 16 countries, aimed to understand how environmental awareness and concern

develop in individuals and whether this leads to pro-environmental behavior (Alıcı, 2013). Palmer's 1999 study focused on the impact of environmental education and its limitations in fostering environmental awareness. The study gathered data from aduşts and children aged 4 to 6 using semi-structured interviews and autobiographical methods. Researchers collected information from 527 children across Slovenia, England, and Greece, to assess their understanding and opinions on various environmental topics. Analyzing children's responses on waste management revealed that U.K. and Slovenian children had a better understanding of waste collection and disposal processes than their Greek peers. Four-year-olds generally recognized the need for household waste management. At the same time, six-year-olds demonstrated more advanced thinking, distinguishing between recyclables and non-recyclables and understanding the different treatments required for each.

Another study related to “Emergent Environmentalism” was performed by Palmer et al. (2003), focusing on how young children from England and Poland understand waste management concepts. The study used a longitudinal approach and included 463 children aged four to ten years. Interviews with children from the U.K. were conducted from 1994 to 2000, while the interviews with Polish children took place in 2000 and 2001. It revealed that children have a basic understanding of waste disposal but must learn about recycling processes. The study emphasizes the importance of effective waste management education in early childhood and highlights the role of teachers in this process. The findings showed that children's understanding of waste management concepts developed over time, with older children showing a more sophisticated understanding. However, misconceptions remained prevalent, particularly regarding the recycling process. The research also underlined the need for more comprehensive and accurate knowledge among children about specific recycling processes, such as what happens to waste after disposal.

The studies highlight that while young children grasp solid waste management's immediate and long-term impacts, they still harbor misconceptions and lack comprehensive knowledge. This finding indicates the necessity for educational programs or curriculum integrations focusing on solid waste management in schools. However, there is a notable scarcity of research on this topic in the literature on early childhood education (Alıcı, 2013).

Tahiri and Maçi (2012) focused on the state of environmental education in Kosovo, particularly waste management. The study analyzed educational curricula and learning materials for lower secondary education (grades VI-IX) to assess students' knowledge about waste management through environmental education. The survey was conducted in two cities, and 216 students aged 10-17 years

participated in the survey, which consisted of 21 questions. Questionnaires were distributed during teaching hours, and the research method was consistent in both cities. Key findings include that many students agreed on the necessity of including environmental subjects in the curriculum. The survey revealed students' understanding (or lack thereof) about waste generation, disposal, and recycling. It also highlighted the students' awareness of recycling companies and the symbols associated with recycling. The study concluded that students have basic knowledge about waste but do not understand waste classification, recycling, and disposal. It observed the absence of structured environmental education activities in schools and the superficial distribution of environmental topics across various subjects. The paper emphasizes the need for better-informed teachers on environmental issues and the importance of cooperation between institutions interested in environmental education. The authors suggest that the existing curriculum should be modified to include a particular subject on the environment and proper waste management to enhance students' understanding and knowledge in these areas.

Dinler et al. (2020) examined the awareness and attitudes of preservice early childhood teachers towards recycling. It utilizes a descriptive field survey model and incorporates qualitative and quantitative data. The participants are 86 teacher candidates from a state university in Kilis, Turkey. The findings reveal that these teacher candidates consider themselves sensitive and willing towards recycling issues. They pay more attention to recycling in school environments than at home. The study identifies a need for more awareness as the primary obstacle to recycling. It also highlights the role of technology like television and the internet in raising awareness about recycling. It suggests recycling education's practical implementation and effectiveness in early childhood settings. While the study addresses teachers' attitudes and awareness, there needs to be more emphasis on how these attitudes translate into practical teaching methods and the impact on children's behavior and understanding of recycling. Further research could explore the effectiveness of different educational approaches and curricula in fostering a deep and lasting understanding of environmental issues among young children.

In their research, Jørgensen and Nielsen (2019) conducted a qualitative case study at a Danish daycare to examine the micro-political dynamics of composting. They used ethnographic methods, including observations and interviews, to understand how sustainable transition policies intersect with early childhood education. Jørgensen and Nielsen’s study (2019) revealed that composting activities in the Danish daycare are not just environmental actions but are entangled in complex micro-political dynamics. They found that these activities, while intended to promote sustainability, often clash with

institutional and municipal waste management policies. This conflict highlights the power struggles and resistance within seemingly benign environmental education practices. Their research underscores the need for a deeper understanding of the socio-political aspects of environmental initiatives in educational settings, suggesting that these activities are not merely ecological but also deeply rooted in societal and policy contexts. The study suggests that further research could explore the long-term impacts of environmental education on children, the adaptability of these programs in different settings, and their implications for broader municipal waste management strategies.

Redman, published in 2013, focuses on advancing educational pedagogy for sustainability. It integrates educational pedagogy, behavior change, and sustainability competencies in a unique approach. The research involved a two-week summer program and a year-long case study with middle and high school students, focusing on food and waste behaviors. It employed hands-on, real-life problem-solving approaches to enhance students' sustainability skills and encourage behaviors that benefit the environment. The program utilized experiential and problem-based methods to enhance sustainability competence and encourage pro-environmental actions. The study observed significant changes in knowledge and behaviors, noting that waste-related behaviors exhibited more long-term change than food-related behaviors influenced by social and cultural factors. It underscores the importance of hands-on, real-world learning experiences in promoting sustainable behaviors and highlights the necessity of educational strategies that extend beyond merely providing information.

Kolbe (2015) examined the perspectives of waste management among students from a grammar and comprehensive school in England. Using questionnaires, the study explored the differences in students' knowledge, attitudes, and behaviors toward waste management. Students in Grammar school were more academically capable than those in comprehensive schools. It revealed that grammar school students generally had higher levels of knowledge, were more likely to recycle, and utilized more sources of information regarding waste management. The study also discusses the importance of waste reduction, noting that neither student group needed to fully recognize the significance of waste reduction and composting compared to recycling. This research highlights the need for enhanced education on waste management, mainly focusing on neglected areas such as waste reduction and composting, and the importance of addressing these gaps in comprehensive schools.

In summary, there is a need for research on more holistic and integrated approaches in environmental education that encompass more than just knowledge transfer, including values, attitudes, and practical skills (Damerell, 2013).

2.4.3. Environmental Literacy and Waste in Turkish Science Curriculum

A curriculum is a framework where knowledge evolves around core elements like values, behaviors, skills and attitudes, shaping an individual in all dimensions (Tatlılıoğlu, 2019). Thus, the curriculum inherently encompasses these components. To accurately understand needs, it is essential to examine the current objectives in the science curriculum and review studies related to waste and waste education.

Growing interest in sustainable development has recently fueled the emphasis on sustainability education, particularly within science education. Freire et al. (2016) suggest that science education can facilitate the necessary framework for this. According to Eilks (2015), almost all educational levels, including science education, aim to support Sustainable Development and foster responsible citizenship. Quinn et al. (2015) emphasize the need to establish and highlight the connection between science and sustainability concepts when teaching sustainability within Science Education.

Science Education, with its interdisciplinary nature encompassing fields like biology, chemistry, physics, astronomy, and geology, offers a broad scope. It includes a range of topics from everyday life issues like biodiversity loss to broader global challenges such as disaster reduction (Tatlılıoğlu, 2019). The objectives related to waste and waste management in the Science Programme published by the Ministry of National Education (MoNE) in 2018 are listed below (Table 2.1).

According to the waste hierarchy, the most favorable waste management approach is initially preventing its production. If avoidance is not feasible, the next preferable step is reusing waste, which maximizes resource and energy conservation. If reduction or reusing is impractical, recycling, composting, and incineration with energy recovery are recommended methods. If none of these options are viable, waste should be sent to landfill (European Parliament and European Council, 2008; Kolbe, 2015). The concepts of reduce, reuse, and recycling, collectively known as the 3Rs approach, are increasingly crucial in diminishing the volume of waste, which has become a significant environmental concern (Aksan & Çelikler, 2019; MoEUCC, 2017). When examined, the objectives mainly relate to recycling and little about reuse. Prevention and reduction should be mentioned in the objectives explicitly. On the other hand, recycling is not a solution for the environment, which is close to down in the waste hierarchy. In the current study, the reduction/prevention of waste is based on the educational program the researcher developed.

Table 2.1. Learning objectives in Turkish science curriculum related to waste/waste management and their cognitive level (MoNE, 2018a, p.19-53).

Grade	Unit	Objectives	Level
3	F.3.7.Electric Vehicles/ Physical Phenomena	F.3.7.2.2. Discuss the damage that battery waste will cause to the environment and what needs to be done about it (p.19).	Understanding
4	F.4.6. Human and Environment / Living Creatures and Life	F.4.6.1.1. Takes care to act economically when using resources. b. The importance of reuse is emphasized (p.24).	A. domain
		F.4.6.1.2. Recognizes the importance of recycling and the resources necessary for life (p.24).	A. domain
7	F.7.4. Pure Substance and Mixtures / Matter and Its Nature	F.7.4.5.1. Distinguishes between recyclable and non-recyclable materials in household waste (p.43).	Analyzing
		F.7.4.5.2. Designs projects to recycle domestic solid and liquid waste (p.43).	Creating
		F.7.4.5.3. Questions recycling in terms of effective use of resources. The contribution of recycling facilities to the economy is emphasized (p.43).	Analyzing
		F.7.4.5.4. Pays attention to waste control in their immediate surroundings (p.43).	A. domain
		F.7.4.5.5. Develop a project to deliver reusable items to those in need (p.43).	Creating
8	F.8.6. Energy Conversions and Environmental Science / Living Creatures and Life	F.8.6.4.1. Takes care to use resources economically/efficiently (p.53)	A. domain
		F.8.6.4.2. Designs projects aimed at resource-efficient use (p.53)	Creating
		F.8.6.4.3. Explains the importance of separating solid waste for recycling (p.53)	Understanding
		F.8.6.4.4. Offers solution suggestions using research data on the contribution of recycling to the country's economy (p.53).	Creating
		F.8.6.4.5. Indicates the problems that may be encountered in the future if resources are not used economically and offer solutions (p.53).	Creating

Table 2.2. Distribution of cognitive objectives of middle schools' science curriculum related to the environment according to the revised Bloom Taxonomy-horizontal dimension.

Grade	# of obj.	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
5	8	■		■		■	
6	1	■		■	■	■	■
7	4	■	■	■		■	
8	9	■		■		■	

Cabbar et al. (2020) focus on analyzing environmental objectives in science and biology curricula over a 12-year formal education period. This analysis uses the Revised Bloom Taxonomy framework, which includes horizontal and vertical dimensions. Horizontal dimensions show cognitive process dimensions, and vertical dimensions show knowledge dimensions. The study found that the environment-related curriculum contained 39 cognitive objectives. On the horizontal dimension, however, upon analysis, it was noteworthy that there were almost no objectives on the application dimension, particularly significant for a topic like the environment across all grade levels. In middle school, there were no cognitive objectives related to the environment for remembering, applying, and evaluating (Table 2.2). Table 2.2 is prepared based on the research from Cabbar et al.'s (2020) study.

The analysis reveals an inhomogeneous distribution of cognitive process dimension gains in the curriculum, particularly highlighting a need for more emphasis on higher-level cognitive processes like evaluation and application across all levels, including middle school. This situation indicates that higher-level cognitive achievements, crucial for deeper understanding and practical application, need to be adequately prioritized in the environmental education framework. Cabbar et al. (2020) suggest assessing how well students can apply their environmental knowledge in real-world situations and the overall impact of these curricula on environmental literacy and behavior; an educational program is developed on packaging waste using PjBL. As a teaching and learning approach, PjBL allows learners to apply their knowledge and skills to real-life situations and evaluate what they get.

The study by Özbuğutu (2021) investigates the status of environmental education concepts in middle school science and social studies programs and high school biology and geography programs in Turkey in 2018 prepared by the Turkish Ministry of Education. The analysis showed that a small percentage of objectives in the social studies, science, biology, and geography programs addressed environmental issues. The study emphasizes the need for updated school programs to reflect the constantly changing environmental problems and effectively enhance students' environmental awareness. Moreover, the study highlighted that the environmental concepts in the programs were predominantly theoretical, suggesting the importance of increasing hands-on learning activities for more effective environmental education. The research also discussed the distribution of environmental-related skills across different grade levels and the need for a more comprehensive approach to assessing students' environmental knowledge and awareness.

Öz-Aydın et al. (2022) studied evaluating the effectiveness of Turkish educational curricula in supporting environmental literacy goals. The 2013 preschool and 2018 life science, science, and biology curricula were examined from preschool to high school, focusing on achieving objectives in awareness, knowledge, skills, attitude and participation related to environmental education. The study reveals that about half of the curriculum's achievements are knowledge-based, primarily emphasizing "ecological foundations." However, it identifies a lack of support for higher-level goals such as "issue resolution," highlighting inconsistencies in the curricula regarding environmental education objectives. With similar findings, Koto (2020) conducted a study focusing on the assessment of environmental education within the 2018 primary school curricula of both Turkey and Ontario (Canada). The evaluation is based on the guiding principles of UNESCO and UNEP. The study employs qualitative research methods and document analysis to gather and analyze data. The findings of this study indicate that while both countries strive to adhere to the principles above, Turkey's curriculum needs to improve in terms of accomplishments related to consciousness, attitude, and participation compared to the other principles.

Yazgan (2023) examined how environmental literacy changed in science education between 1992, 2006, 2013, and 2018, in environmental education in 2015, and in environmental education and climate change courses in 2022 were compared according to years. Document analysis is conducted to examine the environmental content in these curricula and assess their alignment with environmental literacy components such as knowledge, awareness, attitude, skills, and behavior. The research discovers that knowledge components are most frequently represented. At the same time, other aspects like awareness, attitude, skills, and behavior should be more emphasized, indicating a gap in comprehensive environmental literacy education in these programs. The study is a detailed analysis of how environmental literacy components are addressed in science and environmental education programs, particularly in developing behavioral and skill-based outcomes in students.

Similarly, Özbuğutu (2021) found that four of ten primary science curricula objectives directly related to the environment. These objectives focus on environmental science, the relationship between individuals and the environment, and developing awareness, curiosity, and attitudes toward environmental events. While the program's objectives regarding environmental topics were deemed sufficient, it was criticized for lacking environmental skills within the field-specific skills. Both studies emphasize the importance of including environmental skills for effective environmental education within the program.

Growing interest in sustainable development has led to a greater focus on sustainability education within science education. Freire et al. (2016) and Eilks (2015) suggest that science education provides a crucial framework for supporting Sustainable Development and responsible citizenship, while Quinn et al. (2015) emphasize linking science and sustainability concepts in teaching. Science Education's interdisciplinary nature, covering subjects like biology, chemistry, and geology, addresses issues from biodiversity loss to global challenges (Tatlılıoğlu, 2019). The waste hierarchy emphasizes prevention, reuse, and recycling (European et al., 2008; Kolbe, 2015), but current objectives focus too much on recycling. Therefore, this study develops an educational program emphasizing waste reduction and prevention.

Cabbar et al. (2020) highlight an imbalance in cognitive process dimensions in environmental curricula, needing higher-level cognitive processes like evaluation and application. Similarly, Özbuğutu (2021) finds that Turkish middle and high school programs predominantly include theoretical environmental concepts, recommending more hands-on activities. Öz-Aydın et al. (2022) evaluate Turkish curricula's effectiveness, focusing on knowledge-based achievements with insufficient support for higher-level goals like issue resolution. Koto (2020) also identifies areas for improvement in Turkey's primary school curricula compared to Canadian curricula, emphasizing the need to inspire and motivate students to make a difference.

Building on these findings, Yazgan (2023) examines changes in environmental literacy within science education, identifying a need for more emphasis on awareness, attitude, skills, and behavior. This gap suggests further research on effective strategies to enhance practical environmental skills and responsible behaviors in educational curricula. The current study aims to develop a packaging recovery education program to support environmental literacy in various ways.

2.5. Environmental Science and Education

In recent years, environmental science has witnessed rapid advancements, leading to a deeper understanding of ecological systems and the urgent need for sustainable practices. These developments have also influenced educational approaches, emphasizing the integration of innovative strategies to foster environmental literacy and responsibility among learners. Sustainable resource management is an increasingly critical area of environmental science, focusing on optimizing the use of natural resources to minimize waste and environmental impact. The rapid depletion of natural resources and the growing environmental footprint of human activities have

necessitated the development of innovative strategies for efficient resource management (Geissdoerfer et al., 2017).

One of the most promising approaches is the circular economy model, which aims to transform the traditional linear economy of "take, make, dispose" into a closed-loop system where resources are reused, recycled, and regenerated. This approach significantly reduces waste generation and conserves valuable resources (Kirchherr et al., 2017). The circular economy emphasizes designing products with a longer lifespan, using renewable materials, and recovering and recycling materials at the end of a product's life cycle. Implementing circular economy principles can lead to substantial environmental benefits, such as reducing greenhouse gas emissions, lowering pollution levels, and conserving biodiversity (Ellen MacArthur Foundation, 2015).

Another innovative strategy in sustainable resource management is industrial symbiosis, where waste or by-products from one industry become the raw materials for another. This approach reduces waste and enhances resource efficiency and economic competitiveness (Chertow, 2000). For example, in Kalundborg, Denmark, an industrial symbiosis network has been established, where companies exchange resources such as water, steam, and waste materials, leading to significant cost savings and environmental benefits (Jacobsen, 2006).

Integrating sustainable resource management into educational practices is essential for fostering a culture of sustainability among future generations. Schools and universities play a vital role in teaching students the importance of responsible resource use and equipping them with the skills needed to address environmental challenges (Barth et al., 2007).

Curriculum development is a critical component of integrating sustainable practices into education. Educators are designing curricula emphasizing sustainability principles, such as resource conservation, waste reduction, and the circular economy. By incorporating these topics into various subjects, students understand how sustainable resource management impacts different areas of life (Sterling, 2001).

Project-based learning (PjBL) is a practical educational approach to teaching sustainable resource management. Through hands-on projects, students can explore real-world challenges and develop innovative solutions, fostering critical thinking, problem-solving, and collaboration skills (Bell, 2010). For example, students might work on projects to design eco-friendly products, develop

waste reduction strategies, or create sustainable energy solutions, allowing them to apply their knowledge in practical settings (Thomas, 2000).

Campus sustainability initiatives are another way educational institutions promote sustainable resource management. Universities and schools are increasingly implementing practices such as energy-efficient buildings, waste reduction programs, and sustainable food sourcing. These initiatives serve as living laboratories for students, providing opportunities to engage with sustainability tangibly and inspiring them to adopt sustainable practices in their own lives (Leal Filho et al., 2018).

Collaboration with industry and community partners is crucial for enhancing sustainable resource management education. By partnering with businesses, government agencies, and non-profit organizations, educational institutions can provide students with real-world experiences and insights into how sustainable practices are implemented in various sectors (Brundiers et al., 2010). These partnerships also facilitate the exchange of knowledge and resources, supporting the development of innovative solutions to environmental challenges.

Aligning educational practices with the United Nations' Sustainable Development Goals (SDGs), particularly Goal 12, which emphasizes responsible production and consumption, is essential for fostering a global culture of sustainability. By educating students about the importance of sustainable resource management, they can be empowered to become responsible citizens who contribute to a more sustainable future (UN, 2015).

Waste management is a critical aspect of environmental science and has immense educational value. Teaching students about efficient waste management practices addresses immediate environmental concerns and instills a sense of responsibility and stewardship toward the planet. Through project-based learning, students can engage in hands-on activities demonstrating waste reduction, recycling, and resource conservation principles. These experiences foster critical thinking, creativity, and problem-solving skills, empowering students to devise innovative solutions to real-world environmental challenges.

As humans advance their understanding of ecological systems, integrating these insights into educational frameworks empowers students with the skills and knowledge to drive sustainable practices. Education can cultivate a generation of environmentally conscious individuals through strategies like the circular economy, industrial symbiosis, and effective waste management. By

embracing these emerging trends and aligning with global goals such as the UN's Sustainable Development Goals, future generations can be prepared to create a sustainable and resilient world.

3. PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

This study aimed to develop, implement, and evaluate an education program on Packaging Waste Recovery for middle school students, using Project based learning, by examining its impact on students' environmental literacy, environmental knowledge, and attitude toward recovery. To achieve this goal, the following research questions guided this study:

1. Is there any effect of the Packaging Waste Recovery Education Program on the environmental literacy level of middle school students?
   This question is analyzed by testing the hypothesis: There is not any effect on **environmental literacy (EL) level** of the middle school students who received the Packaging Waste Recovery Education Program.

   1.1. Does the Packaging Waste Recovery Education Program affect middle school students' **environmental knowledge** level?
   This question is analysed by testing the hypothesis: It does not have any effect on the **environmental knowledge level** of the middle school students who received the Packaging Waste Recovery Education Program.

   1.2. Does the Packaging Waste Recovery Education Program affect the **affective disposition toward environment** of middle school students?
   This question is analysed by testing the hypothesis: It does not have any effect on the **affective disposition toward environment** of the middle school students who received the Packaging Waste Recovery Education Program.

   1.3. Does the Packaging Waste Recovery Education Program affect middle school students' **environmental problem-solving** level?
   This question is analysed by testing the hypothesis: It does not have any effect on the **environmental problem-solving** level of the middle school students who received the Packaging Waste Recovery Education Program.

   1.4. Does the Packaging Waste Recovery Education Program affect the level of **environmentally responsible behavior** (ERB) of middle school students?

This question is analysed by testing the hypothesis: It does not have any effect on the **environmentally responsible behavior** of the middle school students who received the Packaging Waste Recovery Education Program.

2. Does the Packaging Waste Recovery Education Program affect middle school students' attitudes toward recovery?
   This question is analysed by testing the hypothesis: It does not have any effect on the **attitudes toward recovery** of the middle school students who received the Packaging Waste Recovery Education Program.

3. Is there any effect of the Packaging Waste Recovery Education Program on middle school students' level of knowledge about Packaging Waste Recovery?
   This question is analysed by testing the hypothesis: There is not any effect **on the knowledge about Packaging Waste Recovery level** of the middle school students who received the Packaging Waste Recovery Education Program.

4. How do the students describe their experiences with the Packaging Waste Recovery Education Program?

The operational definitions of the variables are listed in the following sections:

Environmental Literacy (EL): Environmental literacy is described as "embodied by individuals who understand the necessity for environmental action strategies, possess the ability to communicate and apply these strategies, and are also willing to use them to address environmental issues" (Hungerford & Peyton, 1977, p.4). According to Hsu (1997), the four primary components of environmental literacy (EL) are (1) Knowledge, (2) Affect, (3) Skill, and (4) Behavior. In this study, the environmental literacy levels of middle school students were assessed by combining scores from four key aspects: environmental knowledge, affective responses, cognitive skills, and behaviors responsible for the environment.

Packaging Waste Recovery Education Program (PWREP): The program was developed by the researcher for approximately six weeks (12 lessons) under the themes of packaging waste recovery and implemented for middle school 7th grade students between 13 and 14 years old.

4. METHODOLOGY

This chapter presents the study's design, study sample, data collection instruments, content and reliability analyses of all instruments, the intervention program's content, and data analysis.

4.1. Design of the Study

Research designs specify when the information can be collected, from whom, and how it can be collected. This study aimed to evaluate the effect of the *Packaging Waste Recovery Education Program* (PWREP), developed and implemented for middle school students by the researcher, on students' environmental literacy, environmental knowledge, and attitude toward recovery. Pragmatism was adopted as a paradigm, emphasizing the research outcomes, specifically the program's impact on participants. In line with this purpose, the research model was determined as an "experimental design," which is one of the quantitative research methods.

Although one of the research questions is based on qualitative research, qualitative research has been carried out mainly throughout the research. Experimental research is one type of quantitative research method. The researcher manipulates at least one independent variable in the experimental research and observes its effects on dependent variables by controlling other relevant variables (Mills & Gay, 2019). There are three types of experimental design: pre-experimental, quasi-experimental, and true-experimental. The researcher implements an intervention during the experiment in all three types of studies. The pre-experimental design does not use a control group; there is only one single group and no comparison between groups. In true-experiment design, there are control and experimental groups, and the investigator randomly assigns the participants. Quasi-experimental design uses control and experimental groups like true experimental design, but there is a partial or total lack of random assignment (Creswell & Creswell, 2018).

To address the purpose of this study, it is designed as quasi-experimental because random assignment was not possible for the researcher (Mills & Gay, 2019). Since pre-tests and post-tests were used to measure and evaluate current treatment in both experimental and control groups, the present study is a "nonequivalent control group, pretest-posttest design." "Nonequivalent control group, pre-and post-test design" is one of a quasi-experimental research design in which a dependent

variable is measured after the treatment in one group, and the other group, the nonequivalent control group, does not receive the treatment.

The researcher evaluates the differences between the two groups at the start of the study. To ensure proper comparisons and determine if one group outperforms the other on post-tests, efforts should be made to include groups that are as equivalent as possible. The matching technique can be used to equate groups on one or more variables. In pairwise matching, for each participant in one group, the researcher identifies a participant in the other group with the same or a similar score on the control variable (Mills & Gay, 2019). In the current study, before the *Packaging Waste Recovery Education Program* (PWREP) was applied, an Environmental Literacy (EL) Scale with four sub-scales, Packaging Waste Recovery Achievement Test and Attitude Scale Towards Recovery of Packaging Wastes, were applied to the whole 7th grade students to the school where research took place in 2014-2015 Academic Year as pre-tests. EL scores were calculated for each student according to a calculation method used by Erdoğan (2009). The composite EL score of the participants was calculated by combining four components of EL and multiplied by a factor to yield a maximum possible adjusted score of 60 for each conceptual variable. A maximum possible composite score of 240 was calculated by summing up these four weighted scores.

A total of 19 7th grade students volunteered to be in the study where they are called the experimental group. According to the research design, the researcher matched each participant in the experimental group with the rest of the 7th-grade students according to the total EL Scores of each participant in the control group (Table 4.1).

Table 4.1. Environmental literacy scores of experimental and control groups from pre-tests.

Groups		EKT	ADTES	CREBS	PIPSSTE	Score
Experimental group (n=19)	Mean	37.9	36	31.1	36.2	141.2
	Standard deviation	7.23	6.9	4.96	4.53	11.57
Control group (n=19)	Mean	36.6	33	35.5	36.7	141.8
	Standard deviation	7.13	7.91	6.12	5.22	11.37

An independent samples t-test was applied to see the statistical differences between matched pairs of the experimental group and the control group before the intervention. As is seen from Table

4.2., there is no statistical difference between the experiment and control group (U= 368.00, p> .05). The groups are well-matched and parallel before the intervention.

Table 4.2. Independent samples t-test results of experimental and control groups' environmental literacy pre-test scores.

Groups	N	Mean rank	Sum of ranks	U	p
Experimental group	19	19.368421	368.0	368.00	.9534
Control group	19	19.631579	373.0		

Following the selection of the control and experimental groups, the experimental group engaged in the *Packaging Waste Recovery Education Program* (PWREP) created by the researcher. This program involved project-based learning activities centered on packaging waste recovery. Meanwhile, the control group adhered to the Ministry of National Education (MoNE) curriculum as specified in the textbook. The implementation period consisted of six lessons for the control group and 12 lessons (including 6 lessons after school) for the experimental group during the 2014-2015 academic year. Post-tests were implemented for the control and experimental groups right after the intervention. Post-tests allowed the researcher to compare within groups from when the pre-tests were implemented to post-test implementation, as well as differences between groups after the intervention.

Besides the implementation of quantitative instruments, semi-structured interviews were conducted with all participants in the experimental group for the following qualitative research question: How do the students describe their experiences with the *Packaging Waste Recovery Education Program*?

The researcher only conducted the interviews for the experimental group since no treatment was applied to the control group. All the interviews were conducted in ten days after the researcher's instructions and implementation of post-tests. Quantitative and qualitative data were collected concurrently, and the researcher gave equal attention to both.

The instruments, their sequence, and the design of the whole study are given in Table 4.3. Both experimental and control groups had the same tests (except student interviews) for the same period during the study. The only difference is that all participants of the experimental group did the student interviews.

Table 4.3. Research design of the study.

Groups	Pre-test	Intervention	Post-test
Experimental group	a. Environmental Literacy Scale	The Packaging Waste Recovery Education Program	a. Environmental Literacy Scale
	b. Packaging Waste Recovery Achievement Test		b. Packaging Waste Recovery Achievement Test
	c. Attitude Scale Towards Recovery of Packaging Wastes		c. Attitude Scale Towards Recovery of Packaging Wastes
			d. Interviews
Control group	a. Environmental Literacy Scale	Ministry of National Education (MoNE) Curricula	a. Environmental Literacy Scale
	b. Packaging Waste Recovery Achievement Test		b. Packaging Waste Recovery Achievement Test
	c. Attitude Scale Towards Recovery of Packaging Wastes		c. Attitude Scale Towards Recovery of Packaging Wastes

4.2. Study Sample

The study sample was chosen from 7th grade students studying at a foundation school in Istanbul, Turkey, during the 2014-2015 Academic Year. The school was chosen to implement the study since the researcher has worked since 2001. So, the convenience sampling technique was used in collecting data from the study sample, which was easy to reach and contact the researcher. Convenience sampling is one of the non-random sampling approaches and most used in educational research. Seeking volunteers is one of the two examples of convenience sampling (Mills & Gay, 2018). Accordingly, participation in this study was voluntary for the targeted study sample.

The selected foundation school is a 5th through 12th grade, co-educational boarding school for children with deceased fathers or/and mothers whose families are in financial hardship. Students in 5th grade from all regions of Turkey are accepted to the school after being selected with an examination each May/June.

Objectives related to the environment were primarily placed in the Science Education and Social Studies Curricula at the middle school level (MoNE, 2018a; MoNE, 2018b). During the 2014-2015 Academic Year, the current Science Education Program was the 2013 version at the time of the implementation of the intervention program in this study. According to both curricula, the rationale for choosing a study sample from 7th grade is that:

- There were seven objectives during the Science Education Program under the unit called “Structure and Properties of Matter / Maddenin Yapısı ve Özellikleri” directly related to “household waste and recycling” when the current study took place. There was only one more objective in the 8th grade Science Education Program related to household waste/recycling at another level in middle school (Yücel & Özkan, 2013; MoNE, 2018a).
- There were two objectives during Social Studies under the unit called “Bridge between Countries / Ülkeler Arası Köprüler” directly related to global environmental problems such as environmental pollution (MoNE, 2018b).

The study sample was determined with the steps explained below:

- To strengthen the concept of packaging waste recovery in students’ agenda and make them take it more into account during their daily lives, the extra hours for study were planned to take place on two weekdays. Because of students’ social clubs and activities, Wednesdays, and Fridays were the most appropriate days to implement the intervention program after school.
- The researcher announced the research to 7th grade students who stay both Wednesdays and Fridays after school.
- The students who came voluntarily from 7th grade students were defined as a study sample called the experimental group. It consists of 19 students, including four boys and 15 girls.
- Before the instruction program called *Packaging Waste Recovery Education Program*, developed and implemented by the researcher, was applied, an Environmental Literacy Scale with four sub-scales, a Packaging Waste Recovery Achievement Test, and an Attitude Scale Towards Recovery of Packaging Wastes were applied to all 7th grade students at the school in 2014-2015 Academic Year as the pre-test. EL scores were calculated for each student according to a method used by Erdoğan (2009) and Bluhm et al. (1995). The Middle School Environmental Literacy Instrument (MSELI), which was developed by Bluhm et al. (1995), measured four conceptual variables associated with EL (i.e., cognitive knowledge, cognitive skills, affect, and behavior) of the participants. Composite Environmental Literacy (EL) scores of the participants were calculated by combining four components of EL and multiplying by a factor to achieve a

maximum possible adjusted score of 60 for each conceptual variable. By summing these four weighted scores, a maximum possible total or composite score of 240 is obtained.

Descriptive statistics for both experimental and control groups were conducted. As seen in Table 4.4, female students participating in the research make up most of the group in total, with a value of 76.3%. According to this, the total rate of male students is 23.7%. Although there are differences in the total numbers of female and male students, sex distribution is similar for control and experimental groups. The rate of female students in the control group is 73.7%, and the rate is 78.9% for the experimental group. Similarly, the rate of male students in the control group is 26.3%, and the rate in the experimental group is 21.1%. When student distribution regarding boarding status is analyzed, weekend and permanent boarder student numbers are close, especially for the control group. According to this, while about half of the control group is weekend boarder (47.4%), the other half is permanent (52.6%). The number of weekend boarder students for the experimental group is seen to be 1 (5.3%), and the remaining 18 students (94.7%) are seen to be permanent boarders. 78.9% and 63.2% of the students in the control and experimental groups, respectively, answered “Yes” to the question “Have you attended preschool or kindergarten?” The rate of students answering “No” to this question is 21.1% for the control group and 36.8% for the experimental group. According to this, both answers can be said to have a similar distribution for the experimental and control groups. Their age ranges from 13 to 14. According to this, the average age of students in the experimental and control groups are very similar. Besides that, all 38 students participating in the research indicated that they had attended state schools before attending the current foundation school

Table 4.4. Distribution of the students in terms of sex, boarding status, attending pre-school/kindergarten, and average age.

Variables		Control group		Experimental group		Total %
		n	%	n	%	
Sex	Female	14	73.7	15	78.9	76.3
	Male	5	26.3	4	21.1	23.7
Boarding status	Weekend	9	47.4	1	5.3	26.3
	Permanent	10	52.6	18	94.7	73.7
Enrollment to pre-school/Kindergarten	Yes	15	78.9	12	63.2	71.1
	No	4	21.1	7	36.8	28.9
Average age		14.05		14.26		14.16

Table 4.5. Distribution of students participating in the research according to the educational level of the father.

Educational level	Control group		Experimental group	
	n	%	n	%
I don’t know	4	21.1	5	26.3
Illiterate	2	10.5	2	10.5
Primary school	2	10.5	-	-
Secondary school	2	10.5	4	21.1
High school	5	26.3	6	31.6
University	4	21.1	2	10.5
Total	19	100.0	19	100

According to Table 4.5, the fathers of 26.3% of the control group have high school graduate degrees, creating the majority. For the experimental group, students whose fathers have high school graduate degrees constitute the majority (31.6%). Four students in the control group (21.1%) and five in the experimental group (26.3%) stated that they did not know the educational level of their fathers. In the control group, the number of fathers who are non-literate, primary and secondary school graduates is the same. It takes attention that there is no student in the experimental group whose father has a primary school graduate degree.

While 13 students in the control group stated that the father was a worker (4), white-collar (4), and self-employed (5), six students did not provide an answer to this question. In the experimental group, while 15 students stated that their father was a worker (9), white-collar (5), and self-employed (1), four students did not answer this question.

Table 4.6. Distribution of students participating in the research according to the educational level of the mother.

Educational level	Control group		Experimental group	
	n	%	n	%
I don’t know	1	5.3	-	-
Illiterate	2	10.5	4	21.1
Primary school	5	26.3	5	26.3
Secondary school	2	10.5	2	10.5
High school	5	26.3	6	31.6
University	4	21.1	2	10.5
Total	19	100.0	19	100.0

According to the statistics in Table 4.6, while all the students in the experimental group know the educational level of their mothers, one student in the control group does not know the educational

level. The control group mainly consists of students whose mothers have either a primary school graduate degree (26.3%) or a high school graduate degree (26.3%). In general, each number in the mothers' educational levels in the experimental and control groups are the same. Students in the control group indicated that the mother was a housewife (10), teacher (1), self-employed person (1), servant (1), business manager (1), worker (2), tailor (1), accountant (1), and secretary (1), for the experimental group mothers of 16 students were indicated as housewives, two as teachers and one as babysitter. There are no students in the control and experimental groups who did not answer this question.

According to Table 4.7, of the options given to the students regarding the sources from which the students in the control group receive information about environment and nature, the students picked teacher (14), friend (7), family (10), internet (16), school books (12), classes (12), books (15), newspapers and magazines (11), TV shows (13), observations (14) and associations and clubs (10) in the numbers indicated in the round brackets. According to this, technology, books, and teachers are seen as the primary sources of information for the students. The resources from which students in the experimental group receive information about the environment and nature are teacher (18), friend (9), family (13), internet (8), schoolbooks (11), classes (11), books (12), newspapers and magazines (11), TV shows (12), observations (12) and associations and clubs (8) in the numbers indicated in the round brackets. According to this, teachers are seen as the primary sources of information for the experimental group students (Table 4.7).

Table 4.7. Sources of students receive information about the environment and nature.

Groups	Teacher	Friend	Family	Internet	School books	Classes	Books	Newspapers and magazines	TV shows	Observations	Associations and clubs
	f	f	f	f	f	f	f	f	f	f	f
Experimental group	18	9	13	8	11	11	12	11	12	12	8
Control group	14	7	10	16	12	12	15	11	13	14	10
Total	32	16	23	24	23	23	27	22	25	26	18

As seen in Table 4.8, most of the experiment and control group students indicated that they are occasionally interested in the environment and nature. While no students are picking "very low" in the experimental group, it can be said that the numbers of students picking each category are generally close in experimental and control groups.

Table 4.8. Interest in environmental and natural events.

Answers	Control group		Experimental group	
	n	%	n	%
Very low	2	10.5	-	-
Occasionally	12	63.2	13	68.4
High	3	15.8	3	15.8
Quite high	2	10.5	2	10.5

4.3. Data Collection Instruments and Analyses

The summary of the instruments is given in Table 4.9.

Table 4.9. The instruments used in the current study.

Instruments	# of items	Type of items	Develeoped/Adopted by
1. Environmental Knowledge Test (EKT)	35 questions	33 multiple choice and 2 open ended	Developed by the researcher.
2. Problem Identification and Problem-Solving Scale Test Toward Environment (PIPSSTE)	8 questions (Case 1&2)	Ordering, open-ended questions	Developed by the researcher.
3. Affective Disposition Toward Environment Scale (ADTES)	14 items	Ranked five-point scale, ranging from agree to disagree	Adopted for middle school students by the researcher. Original scale belongs to Erdoğan (2009).
4. Children Responsible Environmental Behavior Scale (CREBS)	23 items	A seven-point Likert-type scale ranked from never to more than five times	Adopted for middle school students by the researcher. Original scale belongs to Erdoğan (2009).
5. Packaging Waste Recovery Achievement Test (PWRAT)	13 questions	Three of which are multi-choice and the rest of which are short answered and open-ended	Developed by the researcher.
6. Attitude Scale Towards Recovery of Packaging Wastes	15 items	Likert type, ranked five- point scale	Developed by the researcher.

The following instruments were used as pre- and post-tests for students to measure their EL level as well as their knowledge about packaging waste recovery and attitude towards recovery of packaging wastes:

- Environmental Literacy (EL) Scale which includes four main parts:
  a. Environmental Knowledge Test (EKT)
  b. Children's Responsible Environmental Behavior Scale (CREBS)
  c. The Affective Disposition Toward Environment Scale (ADTES)
  d. Problem Identification and Problem-Solving Skills Test Towards Environment (PIPSSTE)
- Packaging Waste Recovery Achievement Test (PWRAT)
- Attitude Scale Towards Recovery of Packaging Wastes

Interviews with experimental group participants were made right after the Program and recorded since there was no contact with the control group throughout the whole study except pre- and post-tests; the interviews were made only by the experimental group. Besides this, the researcher conducted pilot studies of all instruments in different schools in Sarıyer District, İstanbul. The foundation school where the research was conducted was excluded from these pilot studies.

4.3.1. Environmental Knowledge Test (EKT)

The Environmental Knowledge Test (EKT) was designed to assess the environmental knowledge levels of 6th, 7th, and 8th-grade students and to explore potential relationships between their environmental knowledge levels and demographic attributes. In this study, these relationships were examined. EKT consists of two main parts: *Demographic Information* and *Environmental Knowledge Test*, which the researcher developed.

Demographic information was used to obtain children's sources of environmental knowledge and define the factors affecting their environmental knowledge. The demographic information part, which has 25 items, includes items on students' demographic information (including gender, age, school type, type of the school, enrolment in nursery education, parent education, parent occupation, curiosity about the environment, environmental behavior of parents, source of environmental knowledge, experiences with the environment, training about the environment, parents', teachers', and school administration's concerns about environmental problems). These items were selected by the relevant literature, and a significant relationship was found between the items and environmental knowledge and environmental literacy.

The following steps were proceeded in the development of the instrument:

- As a first step, the researcher reviewed related instruments to investigate middle school students' environmental knowledge in related national and international literature. Research studies about environmental education, environmental knowledge, and environmental literacy at national and international levels were initially reviewed.
- As a second step, the possible environmental objectives were analyzed in 4th, 5th, 6th, 7th, and 8th grade Social Studies and Science Curricula and related textbooks. The analyses were based on the following three assumptions:
    - Social Studies and Science are chosen as subjects to be analyzed since these curricula were found to be more related to Environmental Education (EE) than the others.
    - Middle school education in Turkey is centralized, meaning that all public and private middle schools must adhere to the same curricula issued by the Ministry of National Education (MoNE).
    - All teachers are required to teach according to the standardized curricula.

Analyzed textbooks MoNE published in 2012 and 2013 were chosen since they are widely used and supplied freely by the Ministry to the schools.

More items were elaborated on, including those not included in the Science and Social Studies curricula and textbooks of the 4th to 8th grades, because they were found to be necessary according to the related literature.

- As a third step, the researcher developed an item pool, including 46 questions. The researcher developed 14 questions, whereas eleven were selected from books/the Science and Social Studies Tests of high school entrance exams (Exam of Level Determination – SBS, DPY) conducted between 2002-2011. The rest 21 questions were taken and renewed from different researchers' studies. The list of the researchers and the number of questions used in the present study is given in Appendix A.
- As a fourth step, the question pool was examined by 13 experts, including experts in environmental education, environmental scientists, Turkish elementary and middle school curricula, textbooks, and assessments. The expert opinion was taken from 13 experts before the first pilot testing. These experts examined the appropriateness of the questions for middle school students and revised unclear questions. According to their rich amount of feedback and

recommendations, some of the questions were modified. The question concepts distribution is given in Appendix B. After establishing the content and face validity of EKT, the final version of the instrument became ready with 42 questions for the pilot study as the fifth step.

The instrument was structured in the first and second sections of the EKT to assess its practicality, response rate, and the time required for completion. The time of completion of each scale was recorded for each classroom. The scales were implemented in two consecutive sessions where two open-ended questions were included in the second part of the EKT and on two different days. This format and procedure were chosen because experts felt it was too lengthy for a single sitting, and both sessions examined similar topics.

In the pilot study of the final version of EKT;

- The First Part of the EKT, called Part 1, included 20 multiple choices, and the Second Part of the EKT, called Part 2, which included 22 questions (20 multiple choices - one True/False question - one matching), was implemented at six different schools of 6th, 7^{th} and 8^{th} grades in Sarıyer District, İstanbul in May 2013. Three hundred twenty students took Part 1, whereas 295 took Part 2.
- Each part took approximately 20-25 minutes.
- During the implementation of the Tests, the students' questions and unclear points for students were examined. They were corrected in the final version of the instruments.

Item Analysis

Item analysis was used to improve item and test quality by investigating "the performance of items considered individually either about to some external criterion or about the remaining items on the test" (Thompson & Levitov, 1985, p. 163). Item difficulty and item discrimination are the two most common statistics reported in item analysis.

Item Difficulty

The item difficulty with one correct alternative measure the proportion of examinees who responded to an item correctly. Item difficulty is the ratio of correct responses to an item to the whole group. Item difficulty takes values between 0 and 1. When item difficulty is 0, the item is considered

difficult, and when item difficulty is 1, the item is considered easy. The interpretation of the item difficulty, according to the value it takes, is as follows (Table 4.10).

Table 4.10. Item difficulty values and means.

Item Difficulty	Means
.80 and above	Very easy
Between .65 – .79	Easy
.35 – .64	Moderate
.20 – .34	Difficult
.19 and below	Very difficult

Generally, items with medium difficulty are preferred in item selection for tests. This is because when the item is of medium difficulty, the variance of the item takes the greatest value, which contributes to a more reliable test (Magnusson, 1966).

Item Discrimination

Item discrimination is a metric that evaluates how effectively an item differentiates between examinees who possess knowledge and those who do not. It compares the number of high scorers (i.e. upper group) and low scorers (i.e. lower group) who answer an item correctly.

The possible range of the discrimination index is from -1.0 to 1.0 with an ideal score of +1.00. The item has a negative value if more students in the lower group answer an item correctly than the ones in the upper group. Since item discrimination distinguishes the ones who know and who do not, and it is in favor of the upper group as it gets closer to 1 when the item discrimination gets higher – the closer it is to 1 – the item is better.

In the process of item discrimination index, the test was scored, and rank ordered. 27 percent of the highest scorers who responded correctly called the upper group, and the lowest scorers who responded correctly called lower group were selected. The 27 percent figure is utilized because “this value will maximize differences in normal distributions while providing enough cases for analysis” (Wiersma & Jurs, 1990, p. 145).

In the current study, each item discrimination index was calculated by subtraction of the number of correct answers in the lower group from the number of the correct answers in the upper group and the result was divided by the number of examinees in larger of the two groups. The items were classified according to their discrimination index in Table 4.11.

Table 4.11. Evaluation of discrimination indexes for item analysis (Ebel & Frisbie, 1986).

Index of discrimination item evaluation	Item evaluation
Below .19	Poor items
.20 – .29	Marginal items usually need and subject to improvement
.30 – .39	Reasonably good but subject to improvement
.40 and higher	Good items

In this study, as well as item difficulty and item discrimination statistics, features such as option analysis, whether the test covers all issues, unanswered questions, possible reasons for this, and expert opinions were considered in item selection. In this context, as shown in Table 4.12 and Table 4.13, a matrix showing how options are distributed in upper and lower groups containing the item difficulty and item statistics has been created. For example, although the correct answer to the 12th question in the EKT Part 1 is A, most upper and lower students have chosen option D (Table 4.12). In addition, the upper group is expected to answer a question correctly, and the lower group is expected to answer incorrectly. However, in this question, both groups answered option A or D (even if D is the correct answer) correctly to a large extent. Although the item discrimination index was good, it was decided that this question should be removed from the test due to the low item difficulty index and inappropriate distribution of the options. For example, in EKT Part 1, even though the item difficulty and discrimination index of the 8th question were good, because of the high number of students selected another option other than the correct answer, the options of this item were taken into consideration, and included in the test later again. Since the very similar version of the 16th question in EKT Part 1 takes place in EKT Part 2, it was decided to remove the 16th question from the test, and instead, the question in EKT Part 2, which has a higher item discrimination value, was decided to be kept.

Table 4.13 shows the statistics of the items in EKT Part 2. Items 21 and 22 in this test are not multiple-choice questions. The 21st question is a matching question, and the 22nd is a true or false one.

Therefore, there is no option analysis for these questions. Accordingly, question 21 is difficult since 25 students in the upper group. For this question, it was decided to make some improvements and include it in the test again. Item 22, which is a true/false question, is sufficient for both the item difficulty and discrimination level. The 18th item in EKT Part 2 is included in the test since the discrimination is very high, the difficulty is moderate, and the options work effectively. Again, in EKT Part 2, it was decided to include item 4 after some adjustments since its discrimination value was under .30, although item difficulty was sufficient.

Items that were removed from the test or included in the test after some modifications according to the criteria included in Table 4.12, the distribution of the options, the distribution of the subjects, and expert opinions are as follows:

- Three items (5, 12, and 16) were removed from Environmental Knowledge Test Part 1.
- Nine items (3, 4, 6, 10, 14, 15, 18, 19, and 20) whose discrimination index is between .20 and .39 were kept being improved.
- Since the Kr-20 formula is used for tests whose questions scored either right or wrong, such as multiple choice and true/false, the KR-20 formula was used to calculate the reliability for both EKT Part 1 and Part 2. The reliability coefficient of EKT Part 1 was calculated as .557.

According to the range defined in Table 4.13, four items (4, 7, 19, and 20) were removed from Environmental Knowledge Test Part 2. Some items (2, 5, 8, 12, 13, 14, 17 and 21) whose discrimination index is between .20 and 0.39 were kept being improved. The reliability coefficient of EKT Part 2 was found as .597. Since reliability is equal to or higher than .50 for EKT Part 1 and EKT Part 2 prepared by instructors, it can be accepted as a reliable instrument (Frisbie, 1988).

Table 4.12. Item analysis of Environmental Knowledge Test Part 1.

Item Number	Subject Number	Group	Choices					Total F	Total Empty	Number of Students in the Group: 86	
			A	B	C	D	E			Item Discrimination (r)	Item Difficulty (p)
1	1	UG	0+	0+	1+	*84+	0+	9	0	.44	.76
		LG	9-	17+	3-	*46+	6-				
		%	5.23	9.88	2.33	75.58	3.49				
2	3	UG	4+	6+	*70+	0+	3+	50	0	.65	.49
		LG	19+	11-	*14-	3-	6-				
		%	13.37	9.88	48.84	1.74	5.23				
3	1	UG	5+	17+	1+	8+	*47-	21	0	.38	.35
		LG	10-	38+	5-	13-	*14-				
		%	8.72	31.98	3.49	12.21	35.47				
4	3	UG	19+	0+	0+	*59+	3+	28	1	.35	.51
		LG	30+	3-	5-	*29+	7-				
		%	28.49	1.74	2.91	51.16	5.81				
5	9	UG	8+	*41-	7+	24+	4+	18	2	.15	.40
		LG	10-	*28+	8-	20+	14+				
		%	10.47	40.12	8.72	25.58	10.47				
6	1	UG	4+	4+	4+	3+	*68+	24	3	.37	.60
		LG	15+	7-	4-	10-	*36+				
		%	11.05	6.4	4.65	7.56	60.47				
7	4	UG	3+	3+	2+	4+	*72+	38	2	.51	.58
		LG	11-	4-	13-	6-	*28+				
		%	8.14	4.07	8.72	5.81	58.14				
8	2	UG	0+	0+	*46-	5+	34-	11	1	.44	.51
		LG	6-	4-	*8-	8-	54+				
		%	3.49	2.33	31.4	7.56	51.16				

Item Number	Subject Number	Group	Choices					Total F	Total Empty	Number of Students in the Group: 86	
			A	B	C	D	E			Item Discrimination (r)	Item Difficulty (p)
9	4	UG	15+	*67+	3+	0+	0+	56	3	.65	.45
		LG	21+	*11-	16+	12-	2-				
		%	20.93	45.35	11.05	6.98	1.16				
10	2	UG	4+	*57+	1+	1+	20+	15	0	.37	.48
		LG	9-	*25-	5-	9-	31+				
		%	7.56	47.67	3.49	5.81	29.65				
11	8	UG	5+	*71+	7+	1+	0+	23	2	.62	.52
		LG	18+	*18-	14+	13-	5-				
		%	13.37	51.74	12.21	8.14	2.91				
12	11	UG	*36-	1+	0+	43-	2+	22	1	.14	.35
		LG	*24-	3-	4-	41+	3-				
		%	34.88	2.33	2.33	48.84	2.91				
13	8	UG	9+	5+	*57+	5+	8+	39	4	.43	.45
		LG	10-	12-	*20-	8-	13-				
		%	11.05	9.88	44.77	7.56	12.21				
14	12	UG	23+	1+	4+	*42-	9+	23	3	.29	.34
		LG	15+	15+	9-	*17-	21+				
		%	22.09	9.3	7.56	34.3	17.44				
15	6	UG	*46-	9+	1+	17+	11+	11	1	.37	.35
		LG	*14-	19+	10-	22+	17+				
		%	34.88	16.28	6.4	22.67	16.28				
16	5	UG	10+	4+	*31-	8+	26+	29	1	.23	.24
		LG	21+	5-	*11-	6-	31+				
		%	18.02	5.23	24.42	8.14	33.14				
17	12	UG	*64+	4+	2+	3+	3+	50	2	.59	.45
		LG	*13-	12-	17+	13-	11-				
		%	44.77	9.3	11.05	9.3	8.14				

Item Number	Subject Number	Group	Choices					Total F	Total Empty	Number of Students in the Group: 86	
			A	B	C	D	E			Item Discrimination (r)	Item Difficulty (p)
18	10	UG	*9-	10+	7+	47-	7+	32	3	.22	.44
		LG	*11-	6-	17+	28+	8-				
		%	11.63	9.3	13.95	43.6	8.72				
19	7	UG	2+	3+	8+	8+	*37-	98	4	.21	.33
		LG	9-	8-	11-	6-	*19-				
		%	6.4	6.4	11.05	8.14	32.56				
20	12	UG	15+	5+	6+	*37-	8+	56	2	.24	.31
		LG	18+	7-	7-	*16-	17+				
		%	19.19	6.98	7.56	30.81	14.53				

*: CORRECT OPTION
(0) Questions whose all four elements marked with (+) (QUALIFIED questions)
(1) Questions whose three elements marked with (+) (can be done QUALIFIED by examining)
(2) Questions whose two elements marked with (+) (questions to be reviewed)
(3) Questions whose one element marked with (+) (questions to be reviewed)
(4) Questions whose all elements marked with (-) (UNQUALIFIED questions)
(!) Indicates that the students answering the question concentrate on another option other than the correct option.
(?) Indicates that the number of students in the lower group who answered the question correctly is more than the number of students who answered correctly in the upper group.

Table 4.13. Item analysis of Environmental Knowledge Test Part 2.

Item Number	Subject Number	Group	Choices							Number of Students in the Group: 79		
			A	B	C	D	E	Total F	Total Empty	Result	Item Discrimination (r)	Item Difficulty (p)
1	7	UG	*65+	5+	6+	0+	2+	40	0	1	.47	.59
		LG	*28+	8-	8-	4-	7-					
		%	58.86	8.23	8.86	2.53	5.7					
2	5	UG	5+	10+	*31-	4+	9+	118	1	1	.27	.26
		LG	7-	13+	*10-	4-	9-					
		%	7.59	14.56	25.95	5.06	11.39					
3	6	UG	2+	3+	1+	*63+	9+	23	1	1	.56	.52
		LG	9-	11-	8-	*19-	20+					
		%	6.96	8.86	5.7	51.9	18.35					
4	6	UG	3+	*7-	15+	47-	4+	38	2	2!	.18	.46
		LG	7-	*5-	14+	25+	5-					
		%	6.33	7.59	18.35	45.57	5.7					
5	9	UG	4+	31-	2+	5+	*35-	27	1	1!	.34	.27
		LG	11-	23+	12-	13+	*8-					
		%	9.49	34.18	8.86	11.39	27.22					
6	4	UG	1+	1+	12+	*51-	8+	47	0	1	.52	.39
		LG	6-	7-	20+	*10-	12-					
		%	4.43	5.06	20.25	38.61	12.66					
7	15	UG	15+	2+	23+	*14-	6+	80	2	2!	.15	.22
		LG	14+	7-	11-	*9-	9-					
		%	18.35	5.7	21.52	14.56	9.49					
8	14	UG	20+	8+	2+	11+	*35-	34	1	1	.28	.30
		LG	21+	12-	8-	8-	*13-					
		%	25.95	12.66	6.33	12.03	30.38					

Item Number	Subject Number	Group	Choices					Total F	Total Empty	Result	Number of Students in the Group: 79	
			A	B	C	D	E				Item Discrimination (r)	Item Difficulty (p)
9	1	UG	3+	*64+	10+	0+	1+	22	3	1	.43	.59
		LG	4-	*30+	12-	7-	10-					
		%	4.43	59.49	13.92	4.43	6.96					
10	12	UG	15+	6+	*43-	9+	4+	25	2	1	.41	.34
		LG	16+	10-	*11-	16+	13+					
		%	19.62	10.13	34.18	15.82	10.76					
11	8	UG	*62+	5+	2+	1+	2+	63	0	1	.42	.58
		LG	*29+	11-	5-	4-	5-					
		%	57.59	10.13	4.43	3.16	4.43					
12	10	UG	5+	20+	2+	*41-	5+	46	1	1	.35	.34
		LG	13+	14+	10-	*13-	9-					
		%	11.39	21.52	7.59	34.18	8.86					
13	2	UG	11+	8+	12+	6+	*35-	59	2	1	.37	.26
		LG	22+	12-	11-	9-	*6-					
		%	20.89	12.66	14.56	9.49	25.95					
14	12	UG	51-	3+	*19-	2+	4+	17	3	2!	.27	.51
		LG	30+	6-	*13-	16+	4-					
		%	51.27	5.7	20.25	11.39	5.06					
15	6	UG	1+	*78+	0+	0+	0+	25	0	0	.62	.68
		LG	11-	*29+	8-	8-	6-					
		%	7.59	67.72	5.06	5.06	3.8					
16	3	UG	6+	*53+	12+	4+	2+	53	1	1	.48	.43
		LG	15+	*15-	8-	3-	13+					
		%	13.29	43.04	12.66	4.43	9.49					

Item Number	Subject Number	Group	Choices								Number of Students in the Group: 79	
			A	B	C	D	E	Total F	Total Empty	Result	Item Discrimination (r)	Item Difficulty (p)
17	4	UG	*26-	22+	5+	10+	7+	70	1	1!	.27	.20
		LG	*5-	13+	6-	13+	11-					
		%	19.62	22.15	6.96	14.56	11.39					
18	3	UG	2+	3+	2+	3+	*63+	46	2	1	.72	.44
		LG	14+	11-	14+	7-	*6-					
		%	10.13	8.86	10.13	6.33	43.67					
19	11	UG	*7-	23+	34-	11+	2+	35	1	2!	.03	.08
		LG	*5-	20+	17+	13+	8-					
		%	7.59	27.22	32.28	15.19	6.33					
20	13	UG	5+	9+	*12-	42-	2+	82	3	2!	.09	.11
		LG	6-	13+	*5-	17+	5-					
		%	6.96	13.92	10.76	37.34	4.43					
21	6	UG	*25-						13	1!	.28	.18
		LG	*3-									
		%	17.72									
22	9	UG	*69+						3	1	.56	.59
		LG	*25+									
		%	59.49									

*: CORRECT OPTION
(0) Questions whose all four elements marked with (+) (QUALIFIED questions)
(1) Questions whose three elements marked with (+) (can be done QUALIFIED by examining)
(2) Questions whose two elements marked with (+) (questions to be reviewed)
(3) Questions whose one element marked with (+) (questions to be reviewed)
(4) Questions whose all elements marked with (-) (UNQUALIFIED questions)
(!) Indicates that the students answering the question concentrate on another option other than the correct option.
(?) Indicates that the number of students in the lower group who answered the question correctly is more than the number of students who answered correctly in the upper group.

According to the last version of EKT Part 1 and Part 2, the subject distribution of the instrument are as follows: food chain (2), biological diversity (2), environment and environmental problems (4), environmental protection (3), ecosystem (4), energy (1), erosion (1), recovery/recycling/waste management (5), air pollution (1), light pollution (1), global warming (2), depletion of ozone layer (2), population (3), greenhouse effect (1), water and water pollution (1), soil and land use (2).

Finally, EKT had 35 questions in total. There were 33 multiple-choice questions, where one correct, four incorrect, and an "I do not know" choice was included for each set of items. There was one question where "True," "False," and "I do not know" choices were included. There was one matching question where symbols were matched with the correct explanation (Appendix C).

4.3.2. The Children's Responsible Environmental Behavior Scale (CREBS)

The purpose of the *Children's Responsible Environmental Behavior Scale* (CREBS) is to measure the responsible behavior of 6^{th}, 7^{th}, and 8^{th} graders towards the environment. The scale was adopted from Erdoğan (2012). According to Erdoğan's study, exploratory factor analysis was applied to the data collected from 673 fourth and fifth graders for construct validity. Confirmatory Factor Analysis (CFA) was applied to the data collected from 2410 fifth graders from 78 schools in 26 provinces by Erdoğan (2009). CFA showed that all path coefficients were high and significant at $p < .05$, representing a meaningful contribution of each item to the corresponding scale. According to fit indices (NFI = .90, CFI = .91, and RMSEA = .06.), the four-factor model estimated from data was acceptable.

The *Children's Responsible Environmental Behavior Scale* (CREBS) was applied to the students who participated in the research within the scope of the program to assess their responsibilities towards the environment. This scale consists of 23 positive statements. The scale measures the frequency at which the students have performed the statements given. Frequencies are graded from 1 (Never) to 7 (more than 5). According to this, the lowest score that can be gotten from the scale is 23 (23x1), while the highest is 161 (23x7). According to minimum and maximum scores, the pretest score range of the control group is higher than that of the experimental group. When the means for the pretest are analyzed, the value of the control group is again higher than that of the experimental group. Skewness and kurtosis coefficients are the statistics that provide insight into the distribution of the scores. The value 0 for these statistics refers to a normal distribution. If the skewness is (-), the distribution is skewed to the left, and if the skewness is (+), the distribution is skewed to the right.

Similarly, if kurtosis is (-), the distribution is flattened; if kurtosis is (+), the distribution is sharpened. For a distribution to be considered normal according to skewness and kurtosis coefficients, these two statistics must be between -1 and +1 (Kalaycı, 2005). According to this, skewness, and kurtosis coefficients of CREBS scores of both control and experimental groups range between these values (-1, +1). On this basis, scores of both groups can be said to have a normal distribution.

In Erdoğan's study, CREBS consists of 23 items measured using a seven-point Likert-type scale and four dimensions: political action, eco-management, consumer and economic action, and individual and public persuasion. In his study, the reliability of the CREBS was found to be .89, where Cronbach's alpha correlation coefficient (α) of each factor was given in Table 4.14.

Table 4.14. Reliability coefficient of CREBS (Erdoğan, 2012).

Factors	Number of items	α
Factor 1. Political Action	6	.92
Factor 2. Eco-management	6	.70
Factor 3. Consumer and Economic Action	5	.70
Factor 4. Individual and Public Persuasion	6	.80

Before applying for the pilot test of the instrument, two expert opinions were obtained for content and face validity. The pilot test of the instrument involved 410 students (205 females, 205 males, and five did not indicate their sex), 132 of which were from sixth graders, 141 from seventh graders, and 137 from eighth graders, in six different schools in Sarıyer district, İstanbul.

Scale validity of pre-testing

For the validity of CREBS, Confirmatory Factor Analysis (CFA) was conducted to examine the four-factor model obtained in Erdoğan's study and confirmed in this study's sample. The model was tested using the Maximum Likelihood estimation method with the LISREL 8.7 program.

Confirmatory Factor Analysis (CFA) is a type of analysis used to investigate direct or indirect effects through observed variables. It falls under the framework of Structural Equation Modeling (SEM), so the assumptions applicable to SEM also apply to CFA. While no specific sample size requirements exist for SEM or CFA, larger samples generally lead to more accurate estimates. The simplicity or complexity of a criterion model is used to evaluate whether the sample size is adequate

for CFA. According to Kline (2005), a sample size of 100 is adequate for testing a simple model to obtain accurate estimates. However, in general, a sample size of 100 is deemed “inadequate,” while a sample size between 100 and 200 is considered “medium,” and anything larger than 200 is regarded as “large.” The sample size should be at least 200 if the model is complex. In this study, the sample size is 410. Therefore, it meets the sample size criteria. The assumptions of CFA, such as normality, sample size, and multicollinearity, were met in this data. The four-factor model set between ‘Political Action,’ ‘Eco-management,’ ‘Consumer and Economic Action,’ and ‘Individual and Public Persuasion’ factors and related items are presented in Figure 4.1.

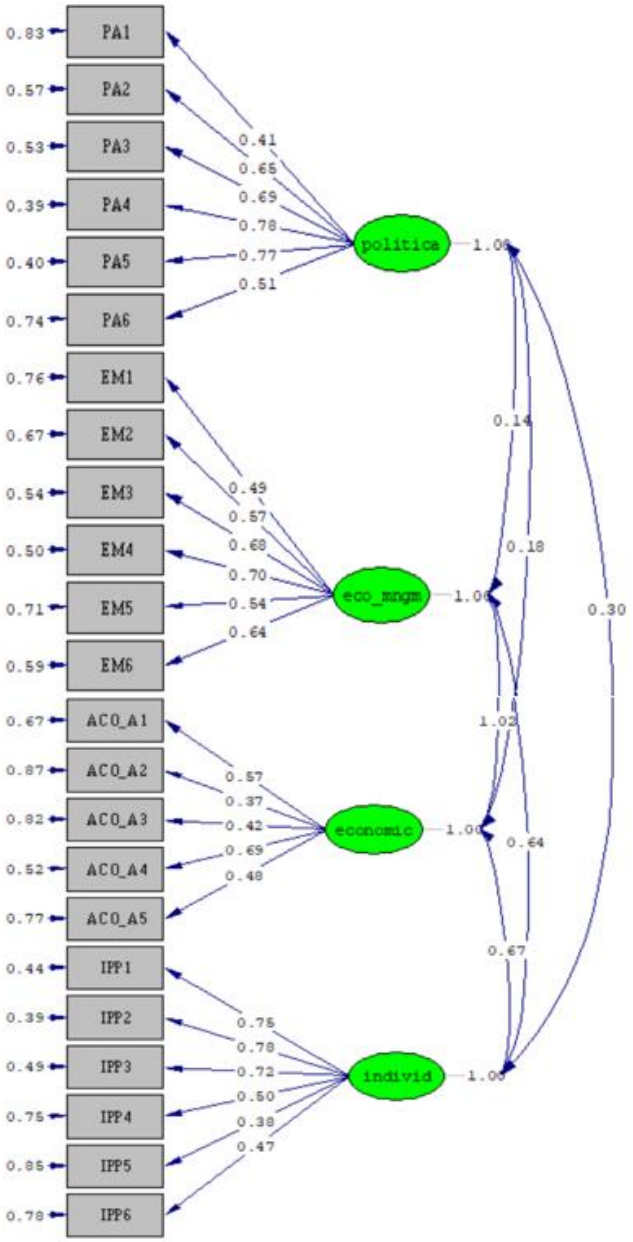

Figure 4.1. Standardized coefficients of confirmatory factor analysis for CREBS.

The model's fit was evaluated according to goodness of fit and error statistics. It is interpreted as a good model fit when error statistics are close to 0 and fit statistics are close to 1. As χ2, one of the fit statistics is sensitive to sample size, the statistics obtained by dividing χ2 by the degree of freedom instead of χ2 was taken as a criterion in interpretation. The fit and error statistics of the CFA analysis are given in Table 4.15.

Table 4.15. Error and fit statistics of the four-factor model.

χ^2	χ^2/df*	RMSEA	SRMR	GFI	IFI	CFI	NNFI
429.17	1.92	.06	.071	.87	.95	.95	.94

*df=224

RMSEA and SRMR values less than or equal to .05 indicate a good fit; values between .05 and .08 indicate a moderate fit, and values between .08 and .10 show an adequate fit (Brown, 2006). If the CFI, NNFI, GFI, and IFI values are greater than .95, it indicates a perfect fit; values above .90 indicate an acceptable fit (Tabachnick & Fidell, 2001). The result of the analysis is RMSEA = .06; SRMR = .071; GFI= .87; IFI= .95; CFI = .95; NNFI= .94. In addition, χ2 = 429.17 (df = 224) was statistically significant (p <.01) and 429.17/ 224 = 1.92. These results suggest that the model has a moderate/good goodness of fit. Therefore, the four-factor model of Erdoğan's study is valid in this study's sample.

Scale reliability of pre-testing

Calculating reliability coefficient(s) for CREBS using Cronbach's Alpha Reliability refers to the consistency of the scores (Fraenkel & Wallen, 2006) and is expressed numerically as a reliability coefficient. Cronbach's alpha reliability coefficient of the first factor, political action, with six items, was found to be .79; of the second factor, physical action/eco-management, with six items, was found to be .78, and the reliability coefficient of the third factor, Economic action, with five items was found .65 and lastly reliability of the fourth factor, Individual and public persuasion, with six items was found .77 (Table 4.16).

Table 4.16. Reliability coefficient of CREBS.

Factors	Number of items	α
Factor 1. Political Action	6	.79
Factor 2. Eco-management	6	.78
Factor 3. Consumer and Economic Action	5	.65
Factor 4. Individual and Public Persuasion	6	.77

CREBS, which consists of 23 positive statements, measures the frequency with which the students have performed the statements given (See Appendix D).

4.3.3. The Affective Disposition Toward Environment Scale (ADTES)

Validity of ADTES

For the validity of the *Affective Disposition Toward Environment Scale* (ADTES), CFA was conducted to examine whether the three-factor model is confirmed in this study's sample. The model was tested using the Maximum Likelihood estimation method with the LISREL 8.7 program. The assumptions of CFA, such as normality, sample size, and multicollinearity, were also met in this data. When the outliers were examined, it was seen that the responses of 26 students were outliers. After deleting those outliers, the analysis was continued on the responses of 339 individuals. The three-factor model set between 'Willingness to Take Environmental Action,' 'Environmental Attitudes,' and 'Environmental Sensitivity' and their items are presented in Figure 4.2.

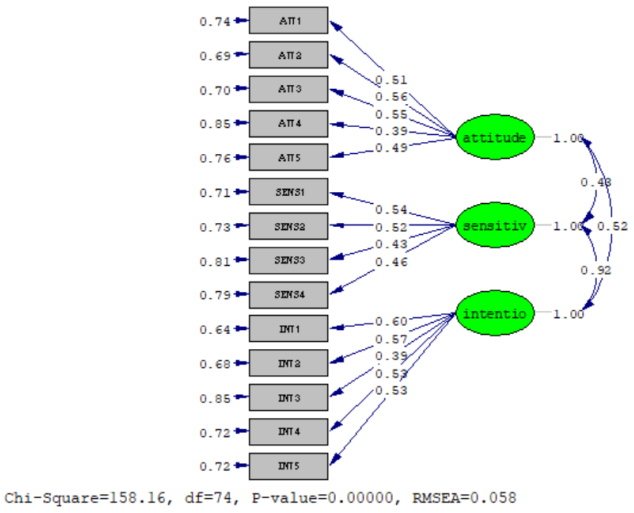

Figure 4.2. Standardized coefficients of confirmatory factor analysis for ADTES.

The model's fit was evaluated according to goodness of fit and error statistics. The fit and error statistics of the CFA analysis are given in Table 4.17.

Table 4.17. Error and fit statistics of the three-factor model of ADTES.

χ^2	χ^2/df*	RMSEA	SRMR	GFI	IFI	CFI	NNFI
158.43	2.14	.058	.022	.94	.93	.93	.92

*df=74

In the literature, it is recommended to use the χ2 / df ratio, called normalized chi-square, because χ2 is sensitive to sample size; in large samples, this ratio is below 3, perfect fit and below five is considered as an indicator of moderate fit (Kline, 2005). As a result of the analysis, RMSEA = .058; SRMR = .022; GFI= .94; IFI= .93; CFI = .93; NNFI= .92. In addition, χ2 = 158.43 (df = 74) was statistically significant (p <.01) and 158.43/ 74 = 2.14. These results suggest that the three-factor model has a perfect goodness of fit. Therefore, the three-factor model of ADTES is valid in this study's sample.

Scale reliability of pre-testing

Cronbach's alpha reliability coefficient of the first factor, Willingness to Take Environmental Action (Intention), with five items, was found to be .80; of the second factor, Environmental Attitudes (Attitudes), with five items, was found to be .71, and the reliability coefficient of the third factor, Environmental Sensitivity (Sensitivity), with four items was found .57. Frisbie (1988) argued that there are no absolute values for interpreting reliability. Instead, the interpretation depends on the intended use of the test results and the importance of the decisions made based on those scores. For tests where scores are used to make significant decisions, reliability is expected to range between .85 and .95. However, for tests prepared by instructors, reliability values of .50 or higher may be considered acceptable. From this perspective, it can be said that the third factor for this research, the *Affective Disposition Toward Environment Scale* (ADTES), has adequate reliability. ADTES consists of 14 statements, all of which are positive (See Appendix E).

4.3.4. The Problem Identification and Problem-Solving Skills Test Towards Environment (PIPSSTE)

Identifying environmental problems and solving them by supporting multi-dimensional development is essential. Because of the limited study on problem-solving skills towards the environment, developing a valid and reliable problem-solving skills test, especially on recovery of packaging waste for middle school students, emerged for the current study.

The researcher developed the *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE) according to three steps in cognitive skills components defined by McBeth et al. (2008), (i.e., issue identification and issue analysis skills and action planning to investigate students' environmental related scientific process skills). Researcher in the development process of the Test, inspired by "The Problem Identification and Problem-Solving Skills Test (PIPSST)," which was developed by Erdoğan (2009). Erdoğan (2009) developed the instrument whose reliability coefficient (α) of the Test was found to be .59 for 5th-grade students. Erdoğan (2009) gave a case related to water pollution and asked two questions related to it. In the first question, the list of the seven mixed possible actions is given and asked students to order to identify the environmental problem in the given case. In the second question, which is open-ended, the students are asked to propose their solution to this environmental problem given in the case.

The researcher increased the cognitive load of the Test for middle school students in the current research by changing the number of the questions as well as revising the case and adding a new case with its questions:

1. The steps' and first case's explanations of water pollution were revised, and the number of steps was raised to eight.
2. The second question in the first part was split into three sub-questions.

One more case, which is about reducing waste and its two main questions, was added to the Test by the researcher as a second part. Erten (2005) suggests that issues such as environmental pollution, environmental protection, and recycling can be effectively addressed in problem-solving. Since the focus of the current study is waste and waste is an everyday environmental problem society faces, the second case's topic, waste, was chosen. The second part also has a case and two main questions:

1. In the first question, the students are asked to order the list of the seven steps to identify people's views about reducing waste in the given case.

2. In the second question, the students are asked to provide their solution for reducing this waste with three sub-questions.

In the first questions of the two parts, the following scientific process skills were examined: identification of the problem, making observations, data collection, preparing experiment and making the experiment, recording data, conclusion, and presentation. The new Test, "*The Problem Identification and Problem-Solving Skills Test Towards Environment*" (PIPSSTE) by the researcher, consists of two parts with four primary and eight open-ended questions.

- The draft test was sent to two specialists (one Turkish literature expert and one measurement and evaluation expert) and evaluated in terms of clarity, understandability, and accuracy. The questions were revised according to their feedback.
- The revised draft test was sent to five experts (one environmental scientist, one measurement and evaluation expert, two science education faculty members, and two middle school science teachers). They were asked to examine the questions and report whether they align with environmental-related topics and objectives in the middle school curricula and textbooks, as well as the purpose of the instrument, content coverage, clearness, understandability, and consistency. Considering the experts' opinions and suggestions, the questions were revised and shortened. The opinions of the experts have provided content and face validity.

Pilot Testing

The pilot testing of the PIPSSTE was conducted with a group of 12 middle school students from 6^{th}, 7^{th}, and 8^{th} grade in March 2013. The researcher took observation notes according to clearness, duration, and difficulty during the pilot administration, and the pilot test results also provided evidence about the students' difficulty while responding to the items. Some items were revised after the pilot test.

Administration of the Instrument

The final version of the Test, consisting of eight questions, was administered at four schools of 6^{th}, 7^{th}, and 8^{th} grades in Sarıyer District in May 2013.

Analyses

The researcher collected data from 250 middle school students whose answers were evaluated and scored by two different raters to diminish the subjectivity of a single scorer. Raters evaluated the first 25 papers separately from each other, created their answer key, and evaluated the papers according to the answer key they created. Then, these raters compared their scores with answer keys and created a standard answer key. They rated 25 papers together according to the answer key they created together. They rated the rest of the papers separately. After rating all the papers, the raters examined the questions and scored highly differently. Then, the scores of the students were calculated by averaging the scores given by the two raters. The inter-rater reliability coefficient between two raters was calculated.

Krippendorf's alpha coefficient examined the interrater reliability. Krippendorff α statistic has similarities with Kappa-type statistics. Both statistics were calculated by considering the total distribution of points regardless of which rater gives which score. However, Krippendorff alfa does not consider the observed and expected consistency as it is done in kappa statistic; instead, it is calculated based on obtaining the observed and expected inconsistency (Krippendorff, 1995: qt. in Bıkmaz, 2011). Since the Krippendorff α statistic can be applied to various data types, it is superior to the Kappa coefficients. Krippendorff α statistic:

- can be applied to any number of values for each variable;
- can be applied to data containing two or more raters;
- can be applied to the data measured through any scale (categorical, ordered, interval, ratio);
- can be used in different sizes of samples (small or big);
- can be applied in situations where data is missing in scoring.

Interrater consistency was separately calculated for each question. .05 confidence level was adopted as the standard for interpreting results. The acquired alpha value for each question is as follows. This method was applied for each question so that the raters' consistency was examined. The alpha coefficient obtained for Krippendorf's six questions is given in Table 4.18.

Table 4.18. Krippendorf's alpha results for each question in PIPSSTE.

Part No	Number of the questions	Krippendorf's alpha coefficient
Part 1	Question 1	.93
	Question 2.1	.89
	Question 2.2	.95
	Question 2.3	.95
Part 2	Question 3	.94
	Question 4	.94

The interpretation of the Krippendorf coefficient is like that of Kappa coefficients. α=1 means that the consistency between raters is perfect, and α= 0 means full inconsistency. In the interpretation of this coefficient, limit levels and their interpretations are specified as follows:

$.80 \leq \alpha$ High level of consistency

$.67 \leq \alpha < .80$ Medium level of consistency

$\alpha < .67$ Low level of consistency

According to this information, interrater consistency for all open-ended questions is significantly high. When evaluated with the data on the interpretation of Krippendorf's alpha coefficient given in Table 4.17, it can be concluded that the raters are perfectly coherent in scoring each question of PIPSSTE. The scores of the students were calculated by taking the average of the scores given by each rater. This test's Cronbach Alpha reliability coefficient was calculated as .55. This coefficient is relatively like the reliability coefficient calculated in Erdoğan's (2009) study.

After it was seen that the consistency between the raters was at an excellent level, the item scores of the students were calculated by taking the average of the scores given by each rater. Then, the difficulty level and discrimination of the questions were calculated, and the psychometric properties of the items were examined. Since the questions were open-ended, item difficulty levels were calculated by dividing the average of the correct answers to each question by the highest score obtained to convert it into an index between 0-1. The discrimination index was examined by calculating the Pearson correlation between the scores obtained from each question and the total score obtained from the test since the items were polytomous. The results are given in Table 4.19.

Table 4.19. Item difficulty and item discrimination of PIPSSTE.

Part no	Number of the questions	Item difficulty (p)	Item discrimination (r)
Part 1	Question 1	.45	.64
	Question 2.1	.39	.38
	Question 2.2	.36	.64
	Question 2.3	.38	.56
Part 2	Question 3	.36	.62
	Question 4	.30	.55

According to Table 4.19, only the fourth question has a high difficulty level, whereas other questions are moderate. When the item discriminations are examined, it can be said that apart from question 2.1, all the items' item discrimination levels are pretty good, and the questions successfully distinguish the students who know and those who do not. Although the discrimination of question 2.1 is not found to be as high as the others because the item difficulty level of this question is at a moderate level, the content of the question is essential, and content validity is provided, it has been decided that the item discrimination is sufficient, and it should be included in the test (See Appendix F).

4.3.5. Attitude Scale Towards Recovery of Packaging Wastes

There have been several attitude scales to measure the general environmental attitudes of high school and middle school students (Atabek-Yiğit et al., 2020; Avan et al., 2011; Gökçe et al., 2007; Uğulu, 2010; Uzun & Sağlam, 2006). The scales include general environmental attitudes since they are mainly designed according to the multidisciplinary features of environmental education. In most of the scales, the number of items on reduce, reuse, recycle, recovery, and packaging was limited by the researcher during the process of the scale's development.

Avan et al. (2011) scale mainly concentrated on recycling and plastic waste. Atabek-Yiğit et al. (2020) aimed to develop a comprehensive scale to assess middle school students' attitudes towards recycling. This analysis revealed a structure comprising three factors and 15 items, accounting for 48.125% of the total variance. However, after Confirmatory Factor Analysis (CFA) using AMOS software and removing an item with a standardized regression weight below 0.5, the final scale confirmed a structure of 3 factors with 14 items. The scale's reliability was established by calculating the Cronbach Alpha coefficient, which was found to be 0.856, indicating a high level of internal consistency.

Developing a valid and reliable attitude scale toward recovery of packaging wastes for middle school students was needed for the current study. The researcher developed it according to the following steps:

Development and Validation of the Item Pool

Writing an essay expressing their opinions about the environment and packaging waste was requested by a group of middle school students. The item pool was built according to a literature review (Gökçe et al., 2007; Uğulu, 2011; Uzun & Sağlam, 2006) and students' responses. As a result, 52 items were developed for the item pool. For formal review, the item pool was sent to two specialists and evaluated regarding content validity, clarity, understandability, accuracy, number of categories in the Likert type scale, and items' length. Keeping items short and minimizing can be effective. Since scale lengths affect responses, expert opinions were also taken on that area. Some items were left out, and the researcher revised some based on expert opinions and suggestions.

Taking Expert Opinions

The draft scale was sent to six experts (two environmental scientists, one environmental engineer who works in the field of packaging waste, two measurement and evaluation experts, one Turkish literature expert, and one science education faculty member) and asked to examine the items regarding their relevance to the purpose of the instrument, content coverage, clearness, understandability, and consistency. According to their opinions and suggestions, some items were revised, three were deleted, and two new items were added. The experts' opinions have provided content validity, which is important for item generation. Since coefficient alpha reliability with Likert-type scales has been shown to increase up to the use of five points, but then it levels off (Lissitz & Green, 1975), the researcher preferred to use Likert-type scale with five points in the current study using classifications like "strongly disagree," "disagree," "undecided," "agree," "strongly agree." Thirty-eight items were kept for the "Attitude Scale Towards Recovery of Packaging Wastes," consisting of 19 positive and 19 negative statements. Finally, a 38-item scale was kept based on expert thoughts and a literature review.

Pilot Testing

The "Attitude Scale Towards Recovery of Packaging Wastes" pilot testing was conducted with 24 middle school students from 6th, 7th, and 8th grade. Students were asked to define the items that were difficult to understand, lengthy, and consisted of unknown words during the administration. These marked items were revised after the pilot test.

Administration of the Instrument

Sample size is recommended for item-to-response ratios ranging from 1:4 (Rummel, 1970) to at least 1:10 (Schwab, 1980) for each set of scales to be factor analyzed. The final version of the scale consists of 38 items and was administered at four schools of 6th, 7th, and 8th grades in Sarıyer District in May 2013. During the administration of the scale, the student's questions and unclear points for students were examined. The researcher herself collected the whole data.

Validity of Attitude Scale Towards Recovery of Packaging Wastes

The validity of the Attitude Scale Towards Recovery of Packaging Wastes was analyzed through explanatory factor analysis. Before starting the analysis, whether the data provided assumptions of factor analysis was analyzed. Analyses carried out within this scope are stated below.

Assumptions of Factor Analysis
Missing Data and Outliers:

As in most parametric tests, one of the premises of factor analysis is that variables do not have outliers. Extreme outliers affect the correlation matrix and increase the possibility of having unrealistic results. In this study, both univariate and multivariate outliers were analyzed. No data was deleted at this point. In this application, since the number of data was relatively good, the range of outliers was kept between -4 and +4. Each individual out of the range was analyzed individually and then deleted. This analysis was carried out on 495 individuals. When N numbers in the table are analyzed, it is observed that this number is 495 in all variables, and there is no missing data. With the exclusion of 46 individuals with values that are out of the range of -4 and +4, the highest and the lowest values of the acquired data are given in Table 4.20.

Table 4.20. The highest and the lowest values of standard scores of variables (After deleting univariate outliers).

Variables	N	Minimum	Maximum	Variables	N	Minimum	Maximum
ITEM01	449	-2.90	.54	ITEM20	449	-3.26	1.11
ITEM02	449	-2.24	2.17	ITEM21	449	-1.72	1.32
ITEM03	449	-3.29	.84	ITEM22	449	-3.06	1.02
ITEM04	449	-3.15	.30	ITEM23	449	-2.69	1.04
ITEM05	449	-3.12	.56	ITEM24	449	-3.38	.69
ITEM06	449	-3.02	.88	ITEM25	449	-3.29	.74
ITEM07	449	-3.86	.72	ITEM26	449	-2.97	.68
ITEM08	449	-2.97	.92	ITEM27	449	-2.79	.87
ITEM09	449	-3.39	.69	ITEM28	449	-3.83	.76
ITEM10	449	-2.63	1.05	ITEM29	449	-3.46	.46
ITEM11	449	-2.47	1.41	ITEM30	449	-3.21	.99
ITEM12	449	-2.08	1.32	ITEM31	449	-2.55	.61
ITEM13	449	-2.26	1.24	ITEM32	449	-2.57	1.41
ITEM14	449	-2.25	1.52	ITEM33	449	-2.35	.85
ITEM15	449	-2.33	.99	ITEM34	449	-3.13	.93
ITEM16	449	-2.96	.41	ITEM35	449	-3.93	.76
ITEM17	449	-2.49	1.21	ITEM36	449	-3.27	.82
ITEM18	449	-3.41	.69	ITEM37	449	-2.84	.80
ITEM19	449	-2.99	.89	ITEM38	449	-3.84	.55

Along with univariate outliers, multivariate outliers should also be deleted. With this aim, Mahalanobis distances of variables were analyzed. The specified measure for multivariate outliers is $p<.001$, a significant Mahalanobis distance value. Mahalanobis distance value calculated for each subject is determined by being compared to the Chi-Square value. The degree of freedom is considered the number of independent quantitative variables. In this study, the number of independent quantitative variables is 38, and the degree of freedom is 38. When the chi-square table is analyzed, the critical value is 73.40 in this degree of freedom. This critical value is a reference for the degree of freedom of 38. According to this, all individuals with the highest values have multivariate outliers.

Mahalanobis distances were ranked from the highest to the lowest; 16 individuals higher than the critical value were excluded from the analysis, and the analysis was carried out with the remaining 433 individuals.

Normality

Another assumption of factor analysis is normality. Multivariate normality was analyzed through Bartlett's Test of Sphericity. According to the test result in Table 4.21, the chi-square value is 2988.496. The significance level is checked to evaluate this value since the acquired sig. Value is <.05, it can be stated that the data has multivariate normality.

Table 4.21. Bartlett's test of sphericity for multivariate normality.

Kaiser-Meyer-Olkin measure of sampling adequacy		.806
Bartlett's test of sphericity	Approx. Chi-Square	2988.496
	df	703
	Sig.	.000

Multicollinearity and Singularity

The issue of multicollinearity arises when there are high correlations between variables, whereas singularity occurs when these correlations reach 1. This implies that variables exhibiting multicollinearity and/or singularity can be used interchangeably. In such cases, it is advisable to choose one of the variables. Upon analyzing the correlation matrix of variables, it was found that no correlation value exceeds .90, indicating that there is no problem with multicollinearity or singularity.

Factorability

Whether the data to be used shall reveal a factor or not is called factorability. Factorability can be analyzed through a couple of methods: a) analysis of correlation matrix, b) analysis of anti-image correlations, and c) analysis of Kaiser-Meyer Olkin (KMO) test. The most commonly used method among them is KMO, and it is demanded factorability that this value is at least higher than .60 and is close to 1 as much as possible. When Table 4.20 is analyzed in this application, data can produce at least one factor since the KMO value is .806, and the result is perfect.

Output of Factor Analysis and Its Interpretation

The first outputs of factor analysis are the results of KMO and Bartlett's test, which are used to evaluate the analysis premises. The results of this test are mentioned above. The acquired factor analysis results of 38 items, which are included in the scale without making any rotation, are given in Table 4.22. A way of determining the number of factors is the evaluation of eigenvalues and the deducted variance rate. Table 4.22 gives eigenvalues and the explained variance values of 38 factors. At this point, the number of eigenvalues that are higher than 1 is a sign of how many dimensions can form the scale. Twelve values are higher than 1. 12 factors explain 55% of the total variance.

Table 4.22. The eigenvalue of factors and the variance rates they explain.

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5.578	14.678	14.678	5.578	14.678	14.678
2	2.591	6.817	21.495	2.591	6.817	21.495
3	1.732	4.558	26.053	1.732	4.558	26.053
4	1.561	4.109	30.161	1.561	4.109	30.161
5	1.454	3.826	33.987	1.454	3.826	33.987
6	1.316	3.463	37.450	1.316	3.463	37.450
7	1.230	3.237	40.687	1.230	3.237	40.687
8	1.183	3.114	43.801	1.183	3.114	43.801
9	1.118	2.941	46.742	1.118	2.941	46.742
10	1.101	2.898	49.640	1.101	2.898	49.640
11	1.062	2.795	52.435	1.062	2.795	52.435
12	1.015	2.670	55.105	1.015	2.670	55.105

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
13	.989	2.603	57.708			
14	.951	2.502	60.210			
15	.934	2.458	62.668			
16	.897	2.360	65.028			
17	.848	2.232	67.260			
18	.820	2.158	69.418			
19	.801	2.107	71.525			
20	.786	2.069	73.594			
21	.758	1.995	75.589			
22	.741	1.951	77.540			
23	.723	1.901	79.441			
24	.693	1.823	81.264			
25	.681	1.791	83.055			
26	.650	1.712	84.767			
27	.618	1.626	86.393			
28	.610	1.605	87.998			
29	.575	1.513	89.511			
30	.531	1.398	90.909			
31	.517	1.361	92.270			
32	.503	1.324	93.594			
33	.471	1.241	94.835			
34	.450	1.183	96.018			
35	.412	1.085	97.103			
36	.395	1.038	98.141			
37	.384	1.012	99.153			
38	.322	.847	10000			

In this study, the varimax rotation technique was used. After the application of the varimax rotation technique, what is expected in the factor analysis is that each item loads on only one factor, or even if it loads on two factors, the difference between the charges of both factors must be higher than .20. In this study, it was detected that items 1, 2, 3, 4, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21,

22, 23, 27, 31, 33, 34 and 37 loaded on more than one factor, and the difference between these charges is less than .20. Such items are called complex items. These items must be excluded from the analysis one by one. After excluding one item, factor analysis is carried out, and all these measures are re-evaluated. This process is carried out each time because an item may not overlap when another item is deleted. In this context, factor analysis was repeated using the varimax rotation technique after excluding each item.

As a result, the factor analysis was repeated and applied with the varimax rotation technique until no overlapping items, Table 4.23 and Table 4.24, were obtained.

Table 4.23. Factor loadings of items.

Items	Factor		
	1	2	3
Item5		.599	
Item7		.589	
Item8		.573	
Item18		.638	
Item19		.674	
Item24	.650		
Item25	.586		
Item26	.626		
Item28	.690		
Item29	.697		
Item30	.617		
Item32			.666
Item35			.791
Item36			.797
Item38			.537

The first factor was named “Awareness towards Recovery” and consisted of five items—the loading value of the first factor changes between .586 and .697. The second factor, “Sensitivity towards Recovery,” comprises six items. The loading value of the second factor changes from .573 to .674. The third factor, “Participation Towards Recovery Activities,” includes four items. The range of the loading value of the third factor is between .537 and .797.

Table 4.24. Eigenvalues and percentages of variance associated with each factor.

Factors	Eigenvalues	% of variance
Factor 1	4.541	25.229
Factor 2	2.009	11.163
Factor 3	1.753	9.737
Total		46.13

According to Table 4.24, there are three main factors whose eigenvalues are higher than 1.00 and whose explained variance ratios are high enough to be considered as factors. Three factors explain 46.13% of the total variance. The first factor explains around 25% of the total variance. Although it is recommended to have a higher percentage of variance, not to have complex items, and to get consistent factors, items that did not meet the criteria were deleted. According to factor analysis and expert opinions, these factors efficiently measure the *Attitude Scale toward Recovery of Packaging Wastes***.**

Reliability of Attitude Scale Towards Recovery of Packaging Wastes

Cronbach's alpha internal consistency coefficient was calculated to determine whether the items of the scale were consistent with each other and as a whole. The names of the factors, the number of items, and the reliability coefficient value of each factor, as well as the whole scale, were summarized in Table 4.25.

Table 4.25. Internal consistency values for the factors of the *Attitude Scale for Recovery of Packaging Wastes*.

Factors	Number of the items	Cronbach alpha value
Factor 1: Awareness towards recovery	6	.669
Factor 2: Sensitivity towards recovery	5	.455
Factor 3: Participation in recovery activities	4	.699
The whole instrument	15	.699

According to these results, the *Attitude Scale for Recovery of Packaging Wastes* is a reliable and valid evaluation tool to measure middle school students (See Appendix G). The instrument consists of a five-point Likert-type scale ranging from 5 (strongly agree) to 1 (strongly disagree). The minimum score can be obtained from the instrument is 15, while maximum score is 75.

4.3.6. Packaging Waste Recovery Achievement Test (PWRAT)

Several knowledge tests related to the environment were examined during the literature review in the study (Alp, 2006; Aydemir, 2007; Barraza & Cuaron, 2004; Kaplowitz & Levine, 2005; Sağır et al., 2008; Yılmaz et al., 2002). The knowledge tests were designed according to the multidisciplinary aspect of environmental education, and waste was one of the areas examined in the tests. Most of the benefits of recycling, including recycling batteries and types of recycling materials, were covered in the tests.

One study mentioned a separate achievement test about recycling made by Uğulu (2011). Uğulu (2011) developed and implemented the instrument called the Recycling Achievement Test for 10th-grade students. It consists of 10 multiple-choice questions: reduce, reuse, recycle. Çimen and Yılmaz (2012) have developed a questionnaire for 6^{th}, 7^{th}, and 8^{th} grade students, consisting of five open-ended questions that mix three knowledge and two behavior items. The questionnaire was implemented to 90 students.

Because of the limited studies examining the knowledge about recovery/recycling, developing a valid and reliable achievement test on recovery of packaging waste for middle school students emerged for the current study. The researcher developed it according to the following steps:

Development of Item Pool

The questions “What do you know and what do you want to know about recycle/reuse/recovery?” were asked to 20 middle school students, and they were requested to write an essay expressing their opinions about the question. Each essay was analyzed and combined with a literature review from national and international resources, including Turkish Science and Social Studies Curricula and Turkish textbooks. The draft test consists of 16 items, four of which are multiple-choice, the rest of which are open-ended, short-answer, sorting questions, and checklists. In three multiple-choice questions, one correct, four incorrect, and one "I do not know" option are included for each set of items.

Taking Expert Opinion

The draft scale was sent to five experts (one environmental scientist, one environmental engineer who works in the field of recovery of packaging waste, one measurement and evaluation expert, one science education faculty member, and one science teacher) and asked to examine the items regarding their relevance to the purpose of the instrument, content coverage, clearness, understandability, and consistency. Some items were revised, and three were deleted, considering the experts' opinions and suggestions. The opinions of the experts have provided content validity.

Pilot Testing

The item pool was sent to two specialists (one Turkish literature expert and one measurement and evaluation expert) and evaluated in terms of clarity, understandability, and accuracy. The items were revised according to their suggestions and opinions. The "*Packaging Waste Recovery Achievement Test*" pilot testing has been conducted with ten middle school students from 6^{th}, 7^{th}, and 8^{th} grades.

Table 4.26. Question-aim distribution of the *Packaging Waste Recovery Achievement Test* (PWRAT).

Question	Aim
1	The definition of reuse (multiple choice)
2	Giving examples of the concept of recovery (multiple choice)
3	Giving examples of the concept of recovery (multiple choice)
4	The definition of recovery
5	The order of steps of the application of recycling
6	The definition of steps of the application of recycling
7	Knowing related environmental symbols about recovery
8	Emphasis of the importance of recovery
9	Categorization of recyclable and nonrecyclable paper waste
10	Knowing output (second product) of recyclable paper waste
11	Categorization of recyclable and nonrecyclable glass waste
12	Categorization of recyclable and nonrecyclable plastic waste
13	Knowing output second product of composite waste

Students were requested to define the questions that were difficult to understand, clear, and consisted of unknown words during the administration. Some items were revised after the pilot test. The Question-Aim Distribution of the *Packaging Waste Recovery Achievement Test* is given in Table 4.26.

Administration of the Instrument

The final version of the Test consisted of 13 questions and was administered at six schools of 6^{th}, 7^{th}, and 8^{th} grades in Sarıyer District in March- April 2013. The researcher herself collected the whole data.

Analyses

The data were collected from 316 middle school students whose answers were evaluated by two raters. Tests that call for more than a one-word response, such as essay tests and short-answer tests, need to be revised about scoring reliability. The consistency of two or more independent scorers gives inter-rater reliability of the Test (Mills & Gay, 2019). In the current study, two raters assessed open-ended questions to omit a single scorer's subjectivity. Raters evaluated 25 papers individually, preparing their own answer key for these common questions and scoring. Later, two raters came together to compare their answer key and scores. Two raters created a common answer key and scorers for 25 papers to minimize the subjectivity. After scoring all the papers, the raters examined the questions and scored exceptionally differently. Since the rest of the questions except three (4, 6 with five subsections, 8) are multiple-choice, two raters read the three questions for whole papers.

Reliability of Scoring

Seven open-ended questions in PWRAT were scored by the researcher and another expert. Interrater consistency was measured through the Krippendorf Alfa coefficient.

Table 4.27 shows the average scores two raters gave each open-ended question and their consistency scores. First, when scores given by raters are analyzed, it is observed that scores given in all applications are highly close to each other.

Table 4.27. Results of Krippendorff α statistic regarding the evaluation of interrater consistency.

Question	Average of the scores given by I	Average of the scores given by II	Krippendorf α
4	.71	.77	.87
6a	.44	.47	.94
6b	.32	.31	.98
6c	.37	.40	.96
6d	.05	.05	1.00
6e	.36	.38	.94
8	.84	.83	.99

The *Packaging Waste Recovery Achievement Test* (PWRAT) consists of 13 questions, 3 of which are multi-choice, and the rest are short-answered and open-ended (See Appendix H).

4.4. Instruction Program

This study aimed to design, execute, and assess an educational program focused on the *Packaging Waste Recovery Education Program* for middle school students through project-based learning. The research examined the program's effect on students' environmental literacy, encompassing environmental knowledge, attitudes, skills, and environmentally responsible behaviors and their knowledge and attitudes toward waste recovery. The independent variable for this study was the teaching approach. The project-based learning instruction program utilized extensive questioning, classroom discussions, and various data representation techniques to enhance environmental literacy and promote environmentally responsible behaviors toward waste management.

The experimental group participated in project-based learning activities focused on recovering packaging waste. In contrast, the control group followed the Ministry of National Education (MoNE) curriculum outlined in the textbook. The implementation period they lasted six lessons for the control group and 12 for the experimental group in the 2014-2015 academic year. To examine whether the *Packaging Waste Recovery Education Program* (PWREP) made a statistically significant difference in students' environmental literacy levels and their knowledge of and attitudes toward recovery, both groups were kept similar during the implementation period. The PWREP was designed to enrich the objectives of the unit subject called "Domestic Waste and Recycling" in the 2013 Science Curricula. The experimental group continued to study after school on Wednesdays and Fridays, with each lesson

lasting 40-90 minutes. Since additional activities enriched the same science objectives, the instruction they received differed. Lesson plans were created according to a template prepared by the researcher, with all lessons designed and written according to this plan.

Since the program was implemented in the 2014-2015 academic year, the objectives related to the unit subject "Domestic Waste and Recycling" from the 2013 science curricula were used. Although the curricula were changed in 2018, no significant changes were made between the 2013 and 2018 science curricula under this unit subject (Table 4.28).

Table 4.28. Comparison of the objectives of the unit subject called "Domestic Waste and Recycling" in 2013 and the 2018 Science Curricula.

Science Curricula Objectives in 2013 (MoNE, 2013)	**Science Curricula Objectives in 2018 (MoNE, 2018)**
Concepts/Topics: Domestic solid waste materials, domestic liquid waste materials, recycling, reuse	Concepts/Topics: Domestic solid waste materials, domestic liquid waste materials, recycling, reuse
7.3.5.1. Distinguish between recyclable and non-recyclable materials in household waste.	F.7.4.5.1. Distinguishes between recyclable and non-recyclable materials in household waste.
7.3.5.2. Design projects to recycle domestic solid and liquid waste.	F.7.4.5.2. Designs projects to recycle domestic solid and liquid waste.
7.3.5.3. Questions recycling in terms of effective use of resources.	F.7.4.5.3. Questions recycling in terms of effective use of resources.
7.3.5.6. The contribution of recycling facilities to the economy is discussed.	***The contribution of recycling facilities to the economy is emphasized.
7.3.5.4. Develop a sense of responsibility for waste control in their immediate surroundings.	*F.7.4.5.4. Pays attention to waste control in their immediate surroundings.
	****a. Public and NGO activities related to waste control are mentioned. (subheading)
	****b. The importance of avoiding contact with medical waste is emphasized. (subheading)
**7.3.5.5. Creates and presents a model for wastewater treatment.	
7.3.5.7. Develop a project to deliver reusable items to those in need.	F.7.4.5.5. Develop a project to deliver reusable items to those in need.

Notes:
* The objective was revised.
** The objective was deleted in 2018.
*** The objective was taken as an explanation.
**** The explanation was added under the objectives.

According to the Ministry of National Education (MoNE)'s science curricula in 2013, there were seven objectives under the unit subject, whereas there were five objectives in 2018 (MoNE, 2013; MoNE, 2018). The changes made were as follows.

- The objective in the 2013 Science Curricula, “7.3.5.5. Creates and presents a model for wastewater treatment,” was deleted in 2018.
- The objective in the 2013 Science Curricula, “7.3.5.6. The contribution of recycling facilities to the economy is discussed,” was revised and included as an explanation under 7.4.5.3 in the 2018 Science Curricula as “The contribution of recycling facilities to the economy is emphasized.”
- The objective in the 2013 Science Curricula, "7.3.5.4. Develop a sense of responsibility for waste control in their immediate surroundings," was revised in the 2018 Curricula to "Pays attention to waste control in their immediate surroundings," and two explanations were added under it in 2018.

The 2013 and 2018 science curricula adopted an inquiry-based learning approach, making the textbook's instructions and activities student-centered to improve students' inquiry and questioning skills (MoNE, 2013; MoNE, 2018).

The experimental group participated in project-based learning activities, whereas the control group experienced traditional methods. Three of the five objectives were enriched with activities under sub-objectives created by the researcher in the *Packaging Waste Recovery Education Program* (PWREP). Since there were no cognitive objectives related to the environment for remembering, applying, and evaluating in the Middle School Science Curricula, the cognitive levels of the sub-objectives were balanced. Two of the five objectives in the MoNE’s Science Curricula were retained as they were suitable for project-based learning. The objectives, sub-objectives, and their cognitive levels are presented in Table 4.29.

This study considers the previously mentioned literature, particularly the features outlined by Krajcik and Blumenfeld (2005), such as driving questions, situated inquiry, collaboration, learning technologies, and artifacts, in planning the *Packaging Waste Recovery Education Program* (PWREP) instruction. Specifically, the project involved building knowledge while simultaneously addressing driving questions. Students participated in research, problem-solving, and decision-making activities under teacher guidance. During this process, they utilized various scientific skills such as formulating questions, making predictions, collecting and analyzing data, and reaching conclusions. This approach helped students connect with their daily lives and the concepts related to their project. Initially, they worked in groups, sharing ideas. Throughout the instruction, students were encouraged to use technology for their research and additional resources such as videos and simulations.

Ultimately, they designed and created an educational pack, implementing it by assigning different tasks to their peers for the term. In light of Krajcik and Blumenfeld's (2005) project-based learning features, the program mainly followed Korkmaz and Kaplan's (2006) stages of PjBL (Table 4.30).

Table 4.29. Objectives, sub-objectives, and the cognitive level of sub-objectives in the PWREP.

PWREP's objectives	R	U	A	An	E	C	Objectives of MoNE (2013)
1. Know the meanings of waste, rubbish, solid, domestic, and packaging waste.	x						F.7.3.5.1. Distinguishes between recyclable and non-recyclable materials in household waste.
2. Estimate how many kg of solid waste is discarded daily and collect and compare estimated and actual data.				x			
3. Classify and interpret packaging wastes according to the Packaging Marking System.		x					
4. Distinguish between recyclable and non-recyclable packaging wastes.			x				
5. Evaluate whether garbage and waste are environmental problems using data on the amount of packaging waste in Turkey and various countries.					x		
6. List the application stages of recycling packaging wastes ("recycling," "classification," "collection," "separation," and "conversion into secondary products") correctly.	x						F.7.3.5.3. Questions recycling in terms of effective use of resources. The contribution of recycling facilities to the economy is emphasized.
7. Give examples of secondary products formed from recycling packaging waste.	x						
8. Develop suggestions to reduce the amount of daily packaging waste produced.						x	F.7.3.5.4. Pays attention to waste control in their immediate surroundings.
9. Give examples of the stages of the Waste Management Hierarchy.	x						
10. Use the symbols related to recycling and recovery in daily life.			x				
11. Explain prevention, reduction, and recovery approaches with examples.		x					
F.7.4.5.2. Designs projects to recycle domestic solid and liquid waste.						x	Project created
F.7.4.5.5. Develop a project to deliver reusable items to those in need.						x	

Note: R - Remembering, U - Understanding, A - Applying, An - Analyzing, E - Evaluating, C - Creating

Table 4.30. Stages of the project-based learning approach (Korkmaz&Kaplan, 2001, p. 196).

Stages	Actions to be taken	The role of the teacher	The role of the student
1. Identifying the topic and sub-topics and organizing the groups within themselves	Students can research sources and propose questions for a framework project. Group members make a project plan together. They decide on questions such as where and how to go and what to learn. They divide the work among themselves.	Presents the general topic of the research and guides the groups in discussing topics and sub-topics.	Create relevant problems, categorize questions, and contribute to forming project groups.
2. Groups create their project plans	Group members make a project plan together. They decide on questions such as where and how to go and what to learn. They divide the work among themselves.	Help groups formulate their projects, hold meetings with them, and help them find the necessary materials and resources.	They plan what they will work on, select resources, define roles, and ensure the distribution of plans.
3. Implement the project	Group members organize and analyze data and information.	Helping to develop research and study skills, controlling basic processes and groups.	Search for answers to their questions. Collect data. Organize information—interview informants. Consolidate and summarize findings.
4. Planning the presentation	Members identify the critical points of their presentation and decide how to present their findings.	Discuss lesson plans for the presentation and organize the process.	Deciding on the presentation's main points, planning how to make a presentation, and preparing materials (video, etc.) for the presentation.
5. Making the presentation	Presentations are made in the classroom and other designated places (other classrooms, other schools, etc.). Students share feedback about the project. Teachers and students share the projects.	Presentations are coordinated.	Presenters give feedback to their classmates.
6. Evaluation	Students share feedback about the project. Teachers and students share the projects.	Project summaries and learning are evaluated.	They reflect on working as group members and what they have learned in their work.

The lessons were planned and implemented according to project-based learning principles. The steps of the experimental group were detailed as follows, according to the stages in Korkmaz and Kaplan's Model (2001).

Stage 1: Identifying the Problem and Formulating Questions

After discussions, the students identified their main problem: why their classmates could have used the recycling bins more efficiently. They proposed various reasons, such as fear, indifference, or lack of knowledge. Based on this, they formulated a question on how recycling bins could be used more efficiently and structured their projects to solve this problem.

Stage 2: Planning and Organizing the Project

Instead of working separately, the students decided to plan a single project and work in sub-groups. Their project plan included the following activities:

Determining the number of garbage bins and recycling bins throughout the school.

Identifying which recycling bins were used inefficiently by examining them regularly for four days and noting their contents. They observed that the most problematic bins were around the canteen, where food and packaged waste were mixed.

Conducting interviews with their peers to understand their opinions about the difference between garbage and waste, what happens to waste after it is thrown into the bins, and why recycling bins were not used efficiently.

Based on their observations and interviews, they determined that the number and positioning of garbage and recycling bins on campus needed improvement.

The students then chose three paths:

Group 1: Prepared an entertaining theatrical play to help their peers distinguish between garbage and waste, throw them in the right place, and convey essential information. They met with the theater teacher, wrote the script, assigned tasks, prepared costumes and decor, and rehearsed.

Group 2: Decide where and how many recycling bins should be placed. They contacted the municipality to request boxes, folded them individually, and placed them in designated locations.

Group 3: Planned the presentation's content by reading the theater group's play. They researched Turkish and English sources to include striking information, visuals, and videos in the presentation.

Stages 3-4: Implementing and Presenting the Project

The students talked to the deputy director about staging the play and set a time and place for it.

Group 1: Performed the theater play. After the play, they asked the audience what they understood and provided clarification where needed.

Group 2: Prepared and placed the recycling bins in the planned locations.

Group 3: Presented their content after the theater play. Their presentation included information about the difference between garbage and waste, the stages of recycling and waste hierarchy, and the importance of prevention and reduction. They also addressed the issue of eating unhealthy packaged food in the cafeteria, which is harmful to nature and health.

Stage 5: Surveying and Analyzing the Results

The students gave the seventh graders a three-question survey about the effectiveness of the theater play. The survey asked what the audience had learned about packaging waste and for their suggestions to improve the study. The new working groups were organized and distributed the duties. One group of students in the experimental group analyzed the survey results. It made notes while another group observed the recycling bins daily for four days to check if the correct items were placed in them.

Stage 6: Sharing and Evaluating the Results

The two groups shared their results. Additionally, the entire project process was evaluated with all students, reflecting on their experiences and outcomes.

The literature supports the researcher's work as a teacher before, during, and after the project (Vasiliene-Vasiliauskiene et al., 2020). In project-based learning, the researcher assumed various roles throughout the implementation process. Initially, the researcher served as a guide, assisting students in selecting topics, brainstorming ideas, setting project objectives, and outlining group proposals. During the project, the researcher acted as an advisor, facilitator, or co-learner, supporting students in generating ideas, setting goals, scheduling, and providing input.

In the post-project phase, the researcher became an evaluator, offering feedback on student learning outcomes, reflecting on strengths and weaknesses, suggesting improvements, and collecting feedback for assessment and project refinement. Overall, the researcher was crucial in guiding, supporting, facilitating, and evaluating student learning in project-based learning environments.

5. RESULTS

The present study was intended to evaluate the *Packaging Waste Recovery Education Program* (PWREP) for middle school students to raise their environmental literacy level, knowledge, and attitude toward recovery. The purpose of this chapter is to present the results of the data collected before and after the implementation of the *Packaging Waste Recovery Education Program*.

5.1. Baseline Information for the Analyses

Before starting the stage of testing hypotheses, descriptive statistics for the results which students in the experimental and control groups received from "*Children's Responsible Environmental Behavior Scale* (CREBS)," "*Environmental Knowledge Test* (EKT)," "*Affective Disposition Toward Environment Scale* (ADTES)," "*Packaging Waste Recovery Achievement Test* (PWRAT), "*Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE)" and "*Attitude Scale Towards Recovery of Packaging Wastes*" which were implemented within the scope of the program were examined. These statistics are given in Table 5.1.

Table 5.1. Descriptive statistics of the pretest scores of students in the experimental and control groups.

Groups	Instruments	N	Minimum	Maximum	Mean	Variance	Skewness	Kurtosis
Control group	CREBS	19	65	127	95.11	268.88	.39	-.01
	EKT	19	65	116	94.37	229.80	-.27	-.17
	ADTES	19	9	42	30.84	54.59	-1.07	3.51
	PWRAT	19	6	20.75	13.76	15.2	-.21	.12
	PIPSSTE	19	12.5	27	17.84	14.75	1.09	1.15
	Attitude	19	28	57	46.05	58.28	-0.52	.00
Experimental group	CREBS	19	56	104	83.32	176.90	-.51	-.38
	EKT	19	62	113	95.79	335.06	-.22	-.79
	ADTES	19	8	38	33.74	41.76	-3.85	16.01
	PWRAT	19	8	17	13.61	5.43	-.86	.60
	PIPSSTE	19	12	25	17.18	9.37	.56	1.05
	Attitude	19	36	57	48.79	23.95	-.96	1.74

Environmental Knowledge Test (EKT) consists of 35 questions, 33 of which are multiple choice and 2 of which are open-ended. According to this, the lowest score that can be received from the Test is 0 (35x0), and the highest score is 140 (35x4). When the pretest scores of experimental and control groups are examined, it is seen that both groups' minimum, maximum, and average scores are close.

When variances for EKT are examined, it is seen that the variance of the scores, especially the experimental group, is higher, indicating that changes in the scores of the experimental group are higher. EKT scores are normally distributed in both experimental and control groups.

Affective Disposition Toward Environment Scale (ADTES) consists of 14 statements, all of which are positive. The lowest score from the scale, which is graded between 1 (strongly disagree) and 4 (strongly agree), is calculated as 14 (14x1), and the highest score is calculated as 56 (14x4). When ADTES pretest scores of experimental and control groups are analyzed, the minimum scores of both groups are seen to be close to each other. According to the highest score calculated, none of the students received the full score. The scores of the experimental and control groups are close to each other in terms of maximum scores. Though the highest minimum and maximum scores are in the control groups, the average value of the experimental group is higher than that of the control group. According to variances, the scores of the students in the control group vary more than those of the students in the experimental group. Skewness and kurtosis values are quite high for both the experiment and the control groups, and these statistics show that the scores of both groups are skewed to the left and are flattered. The fact that the distribution is skewed to the left means that scores are slightly higher than normal, and the fact that the distribution is flattered means that changes between the scores are high.

Packaging Waste Recovery Achievement Test (PWRAT) consists of 13 questions, 3 of which are multi-choice, and the rest are short-answered and open-ended. Two different raters evaluated the students' answers. Raters both evaluated the first 20 test papers according to the answer key. They evaluated the rest of the papers separately. Then, the scores given by the two raters were averaged, thus calculating the scores of the students. The score values of the questions were set to be different from each other, and the items were graded as minimum 0 and maximum 6. When the scores of the experimental and control groups are compared, the average scores of the two groups can be seen to be close. When skewness and kurtosis coefficients are analyzed to assess the scores' distribution, both groups' scores are normally distributed.

Problem Identification and Problem-Solving Skills Test Towards Environment (PIPSSTE) consists of 4 sections and eight open-ended questions. Two different raters rated answers to the questions. Raters evaluated the first 25 papers separately from each other, created an answer key, and evaluated the papers according to the answer key they created. Then, these raters compared their answer keys and created a common answer key. They rated the 25 papers according to the answer

key they created together. They rated the rest of the papers separately. Then, the scores of the students were calculated by averaging the scores given by the two raters. The score values of the questions were set as different from each other, and the items were graded as minimum 0 and maximum 7. The score value of each question was set to be different from each other. According to the descriptive statistics in Table 30, though the minimum scores of the experiment and the control groups are close, a slight change in favor of the control group is seen in the maximum scores. According to average scores, both groups are found to have close values. Regarding the skewness and kurtosis values, though scores in the experimental group have a skewness close to normal, the kurtosis value is different from normal values. The skewness and kurtosis values of the control group are different from the normal values.

One of the behaviors planned to be developed within the program's scope is an attitude toward recovering packaging waste. For this reason, researcher developed an "*Attitude Scale for Recovery of Packaging Wastes*". The scale consists of 15 items, 5 of which are negative. Negative items in this scale are scored inversely. The scale is a Likert Type, graded between 1 and 5, and the lowest score that can be obtained from this scale is 15 (15x1), while the highest score is 75 (15x5). When the pretest scale scores of the control and the experimental groups are analyzed in light of this information, the first point that attracts attention is that the highest score, 75, could be obtained in either of the two groups. Attitude scores of the students in the control group range from 28 to 57, and the scores of the experimental group range from 36 to 57. When maximum and minimum scores and averages are analyzed, the scores of the experimental group are slightly higher. Regarding the variances of the individuals in both groups, the scores of the students in the control group vary more. Finally, the Attitude Scale Towards Recovery of Packaging Wastes has a normal distribution for both groups according to skewness and kurtosis values.

Besides research questions, assumptions of statistical tests such as sample size, nature of the variables, and distribution of the scores are considered when deciding which statistical Test to use. Based on this, tests that compare the averages were adopted by considering the research questions. As the experimental and control groups are two different groups, a t-test was decided to be adopted for independent groups. However, because sample size is few, the Mann Whitney U test, which is a non-parametric equivalent of this Test, was decided to be used (Büyüköztürk, 2002).

Results of Mann Whitney U test to determine whether the scores got by the students in the experimental and control groups from the scales implemented within the scope of the pretest are different from each other are given below.

Table 5.2. Mann Whitney U Test results for CREBS pretest scores of experimental and control groups.

Groups	N	Mean rank	Sum of ranks	U	p
Control group	19	23.11	439	1120	.045
Experimental group	19	15.89	302		

According to the results of Mann Whitney U test results in Table 5.2, there are statistical differences between *the Children's Responsible Environmental Behavior Scale* (CREBS) pretest results of the individuals in the experimental and control groups ($U=1120$, $p<.05$). When statistics in Table 5.1 and mean ranks in Table 5.2 are examined, this difference is seen to be in favor of the control group. According to this, the CREBS pretest scores of the control group are higher than those of the experimental group. Though there is a statistical difference between the scores of the two groups, this difference is very close to the limit value; in other words, differences between the scores can be similar.

Table 5.3. Mann Whitney U Test results for EKT pretest scores of experimental and control groups.

Groups	N	Mean rank	Sum of ranks	U	p
Control group	19	20.13	382.50	168.5	.729
Experimental group	19	18.87	358.50		

Mann Whitney U test results regarding the comparison of the pretest scores of experimental and control groups for *the Environmental Knowledge Test* (EKT) are given in Table 5.3. According to this, there is statistically no difference between the Environmental Knowledge Test results of the individuals in the experimental and control groups ($U=168.5$, $p>.05$).

Table 5.4. Mann Whitney U Test results of ADTES pretest scores of experimental and control groups.

Groups	N	Mean rank	Sum of ranks	U	p
Control group	19	15.08	286.50	96.500	.014
Experimental group	19	23.92	454.50		

According to Mann Whitney U test results in Table 5.4, there is a statistical difference between the *Affective Disposition Toward Environment Scale* (ADTES) pretest scores of the individuals in the experimental and control groups (U=96.50, p<.05). When statistics in Table 5.1 and mean ranks in Table 5.4 are examined, this difference is seen to be in favor of experimental group. According to this, the ADTES pretest scores of the experimental group are higher than those of the control group.

Table 5.5. Mann Whitney U Test results of PWRAT pretest scores of the experimental and control groups.

Groups	N	Mean rank	Sum of ranks	U	p
Control group	19	20	380	1710	.781
Experimental group	19	19	361		

According to Mann Whitney U test results in Table 5.5, there is statistically no difference between the *Packaging Waste Recovery Achievement Test (*PWRAT) pretest results of the individuals in the experimental and control groups (U=1710, p>.05).

Table 5.6. Mann Whitney U Test results of PIPSSTE pretest scores of the experimental and control groups.

Groups	N	Mean rank	Sum of ranks	U	p
Control group	19	20.08	381.50	169.500	.747
Experimental group	19	18.92	359.50		

According to Mann Whitney U test results in Table 5.6, there is there is statistically no difference between *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE) Pretest scores of the individuals in experimental and control groups (U=169.500, p>.05).

Table 5.7. Mann Whitney U Test results *Attitude Scale Towards Recovery of Packaging Wastes* pretest scores of the experimental and control groups.

Groups	N	Mean rank	Sum of ranks	U	p
Control group	19	17.74	337.00	147.000	.339
Experimental group	19	21.26	404.00		

According to Mann Whitney U test results in Table 5.7, there is statistically no difference between the *Attitude Scale Towards Recovery of Packaging Wastes* pretest scores of the individuals in the experimental and control groups (U=147.000, p>.05).

5.2. Result for the Tested Hypotheses

All the scales that had been implemented at the beginning of the intervention program were also implemented at the end of the intervention program to all students who participated in the research, and the descriptive statistics obtained are given in Table 5.8.

When the *Children's Responsible Environmental Behavior Scale* (CREBS) scores given in Table 5.1 and Table 5.8 are compared, it is seen that the scores of the students included in the experimental group significantly increased after the intervention program. Although some increase was also seen in the CREBS scores of the control group, it is a slight one.

Table 5.8. Descriptive statistics regarding the posttest scores of the students in experimental and control groups.

Groups	Instruments	N	Minimum	Maximum	Mean	Variance	Skewness	Kurtosis
Control group	CREBS	19	51	132	99.26	450.98	-.63	.11
	EKT	19	82	128	101.58	179.70	.72	.90
	ADTES	19	42	56	48.26	21.43	.09	-1.517
	PWRAT	19	7.5	17.5	13.658	8.17	-.57	-.32
	PIPSSTE	19	9	20	16.53	7.26	-1.05	2.06
	Attitude	19	42	59	50.47	24.93	-0.72	-1.05
Experimental group	CREBS	19	95	130	112.79	115.73	.04	-1.06
	EKT	19	58	130	103.32	377.78	-.80	.56
	ADTES	19	46	55	50.95	7.50	-.43	-.86
	PWRAT	19	27	36	30.68	7.78	.55	-.77
	PIPSSTE	19	16	29	21.18	7.51	.88	2.95
	Attitude	19	41	60	54.00	28.22	-1.34	1.67

When the scores obtained from the *Environmental Knowledge Test* (EKT) were examined, it can be said that both the latest scores of the experimental group and control group were a little higher than the scores of the pretest, and the increase seen in both groups is quite close to each other.

When the scores obtained from the *Affective Disposition Toward Environment Scale* (ADTES) compared to the pretest results, it can be said that the latest scores of the experimental group and

control group were higher than the pretest scores, and the increase seen in the experimental group is higher than the control group's increase.

When the scores gained from the *Packaging Waste Recovery Achievement Test (*PWRAT) are examined comparatively for the pretest and posttest, it is noted that there is a slight decrease in the posttest scores of the control group. Despite this, it is seen that the posttest scores of the experimental group are more than the pretest scores.

A similar situation also arises for the *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE). According to this, the pretest scores of the control group are lower than the posttest scores in problem-solving. Within 12 sessions, when the intervention program was implemented, the problem-identification and problem-solving skills of the students in the control group degraded a bit. Despite this, the posttest scores of the students in the experimental group are higher than the pretest scores in PIPSSTE.

Last of all, in the scores gained in the *Attitude Scale Towards Recovery of Packaging Wastes*, an increase in the posttest scores of the students in the experimental group and control group is seen. The posttest scores of the students in the experimental group are higher than the pretest scores in the *Attitude Scale Towards Recovery of Packaging Wastes*.

According to these findings, there is a difference between the pretest and posttest scores of the experimental group, and this difference is for the benefit of posttests in all scales. The test that can be used to determine whether these differences detected are statistically meaningful or not is t test for dependent groups (Büyüköztürk, 2002). Here, as the sample size is small, it is decided to use the Wilcoxon signed rank test, which is one of the non-parametrical equivalents of the t-test for dependent groups (Büyüköztürk, 2002).

5.2.1. Test of the First Hypothesis

The initial comparison revealed no significant disparity in the environmental literacy (EL) levels between the two groups. The subsequent section focuses on evaluating the impact of the instructional program. This assessment encompasses four dimensions of EL and examines changes in attitudes and knowledge related to recovery according to, as outlined in the following discussion.

The first hypothesis of the current study was “There is not any effect **on environmental literacy (EL) level** of the middle school students who received the *Packaging Waste Recovery Education Program*.”

Firstly, it is examined that if there is a difference between the EL pretest scores of experimental group and control group with Mann Whitney U test.

Table 5.9. Mann Whitney U Test results of the EL pretest scores of the experiment and control group.

Groups	N	Mean rank	Sum of ranks	U	p
Control group	19	20.58	391	1600	.550
Experimental group	19	18.42	350		

According to the results of Mann Whitney U test (Table 5.9), there is no statistical differences between the EL pretest scores between the persons in experimental group and control group (U=1600, p>.05).

After CREBS, EKT, ADTES and PIPSSTE posttest scores are transformed to 60 points and they added up, the Environmental Literacy (EL) scores were obtained According to Table 5.10, there is difference between EL posttest and pretest scores of the students in the experimental group (z=-3.823, p<.05). According to mean ranks, posttest scores of the students in the experimental group are higher than their pretest scores.

Table 5.10. Comparison between EL total scores of the students in experimental group with Wilcoxon Signed Rank Test.

		N	Mean rank	Sum of ranks	z	p
EL pretest - EL posttest	Negative ranks	0			-3.823	.000
	Positive ranks	19	10	190		
	Equation	0				

*For the benefit of negative ranks

This result shows that the first hypothesis was falsified because of a significant positive increase in the experimental group's relevant EL level.

5.2.1.1. The first sub-hypothesis of the first research question. The first sub-hypothesis of the first research question of the current study was "It does not have any effect on the environmental knowledge level of the middle school students who received the Packaging Waste Recovery Education Program."

Table 5.11. The comparison of the EKT scores of the students in experimental group with Wilcoxon Signed Rank Test.

		N	Mean rank	Sum of ranks	z	p
EKT– Posttest- Pretest	Negative ranks	4	10.63	42.50	-2.115	.034
	Positive ranks	15	9.83	147.50		
	Equation	0				

When the results shown in Table 5.11 are examined, it is seen that the posttest scores that the students in the experimental group gained from the *Environmental Knowledge Test* (EKT) are statistically different from the scores they gained from the pretest ($z=-2.115$, $p<.05$). When mean ranks and descriptive statistics are evaluated together, it is understood that the scores students gained from posttest are higher than the scores they gained from the pretest. According to this, it can be said that students' environmental knowledge increased after the intervention program.

This result shows that the first sub-hypothesis of the first hypothesis was falsified because there is a significant positive increase in the experimental group's relevant environmental knowledge.

5.2.1.2. The second sub-hypothesis of the first research question. The second sub-hypothesis of the first research question of the current study was "It does not have any effect on affective disposition toward an environment of the middle school students who received the Packaging Waste Recovery Education Program".

Table 5.12. The comparison between ADTES total scores of the students in experimental group with Wilcoxon Signed Rank Test.

		N	Mean rank	Sum of ranks	z	p
ADTES Posttest-Pretest	Negative ranks	19	10.00	190.00	-3.846	0.000
	Positive ranks	0	.00	.00		
	Ties	0				

* For the benefit of positive ranks

According to Table 5.12, there is difference between ADTES posttest and pretest scores of the students in the experimental group (z=-3.846, p <.05). According to mean ranks, posttest scores of the students in the experimental group are higher than their pretest scores.

This result shows that the second sub-hypothesis of the first research question was falsified because there is a significant positive increase in the experimental group's relevant **affective disposition toward an environment**.

5.2.1.3. The third sub-hypothesis of the first research question. The third sub-hypothesis of the first research question of the current study was "It does not have any effect on environmental problem-solving level of the middle school students who received the Packaging Waste Recovery Education Program".

According to the results of the Wilcoxon signed rank test shown in Table 5.13, it is seen that the posttest scores the students in the experimental group gained in the *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE) are statistically different from their pretest scores (z=-3.567, p<.05). According to the mean ranks and descriptive statistics, posttest scores of the students in the experimental group is higher than their pretest scores.

Table 5.13. The comparison of the PIPSSTE scores of the students in experimental group with Wilcoxon Signed Rank Test.

		N	Mean rank	Sum of ranks	z	p
PIPSSTE Posttest-Pretest	Negative ranks	1	6.50	6.50	-3.567*	.000
	Positive ranks	18	10.19	183.50		
	Equation	0				

* For the benefit of negative ranks

This result shows that the third sub-hypothesis of the first hypothesis was falsified because there was a significant positive increase in the experimental group's relevant the *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE).

5.2.1.4. The forth sub-hypothesis of the first research question. The forth sub-hypothesis of the first research question of the current study was "It does not have any effect on environmentally responsible behavior of the middle school students who received the *Packaging Waste Recovery Education Program*."

Table 5.14. The comparison of the CREBS scores of students in experimental group with Wilcoxon Signed Rank Test.

		N	Mean rank	Sum of ranks	z	p
CREBS Posttest- Pretest	Negative ranks	0			-3.824*	.000
	Positive ranks	19	10	190		
	Equation	0				

*For the benefit of negative ranks

According to the test results shown in Table 5.14, there is a meaningful difference between the pretest and posttest scores of the students in the experimental group in CREBS (z=-3.824, p <.05). When Table 5.1 and Table 5.8 are evaluated together, it is seen that the posttest scores of the students are higher than the pretest scores. According to this, the CREBS features of the students in the experimental group were increased after the intervention program was practiced.

This result shows that the fourth sub-hypothesis of the first hypothesis was falsified because there was a significant positive increase in the experimental group relevant **to environmentally responsible behavior.**

5.2.2. Test of the Second Hypothesis

The second hypothesis of the current study was "It does not have any effect on **attitudes toward recovery** of the middle school students who received the *Packaging Waste Recovery Education Program*."

Table 5.15. The comparison of the *Attitude Scale Towards Recovery of Packaging Wastes* scores of the students in experimental group with Wilcoxon Signed Rank Test.

		N	Mean rank	Sum of ranks	z	p
Attitude Scale Towards Recovery of Packaging Wastes Posttest-Pretest	Negative ranks	3	4.67	14.00	-3.12*	.002
	Positive ranks	15	10.47	157.00		
	Equation	1				

* For the benefit of negative ranks

According to the results shown in Table 5.15, it is seen that the posttest scores the students in the experimental group gained in the *Attitude Scale Towards Recovery of Packaging Wastes* are statistically different from their pretest scores (z=-3.12, p<.05). According to the mean ranks and descriptive statistics, posttest scores of the students in the experimental group is higher than their pretest scores.

This result shows that the second hypothesis was falsified because there was a significant positive increase in the experimental group relevant **to attitudes toward recovery.**

5.2.3. Test of the Third Hypothesis

The third hypothesis of the current study was "There is not any effect **on knowledge about Packaging Waste Recovery level** of the middle school students who received the *Packaging Waste Recovery Education Program*."

Table 5.16. The comparison of the PWRAT scores of the students in the experimental group with Wilcoxon Signed Rank Test.

		N	Mean rank	Sum of ranks	z	p
PWRAT Posttest-Pretest	Negative ranks	0			-3.829*	.000
	Positive ranks	19	10	190		
	Equation	0				

* For the benefit of negative ranks

According to the results of the Wilcoxon signed rank test in Table 5.16, which was implemented to detect whether there is a difference in the *Packaging Waste Recovery Achievement Test* (PWRAT) scores of the students in the experimental group before and after the training, there is a meaningful difference between the students' PWRAT pretest and posttest scores ($z=-3.829$, $p<.05$). When mean ranks and descriptive statistics are evaluated together, it is seen that the scores students gained from the posttest are higher than the scores they gained from the pretest. According to this, it can be said that students' PWRAT increased after the training.

This result shows that the third hypothesis was falsified because there was a significant positive increase in the experimental group relevant to the **knowledge about the level of packaging waste recovery.**

5.3. Results of the Fourth Research Question

Data Collection

Interviews were employed as a qualitative data collection method. The researcher conducted semi-structured interviews aligned with the research questions. Adams (2015) suggests that semi-

structured interviews are suitable for formative program evaluation and are ideal for one-on-one sessions with key program staff, such as participants. These interviews were conducted within ten days after the instructional program's completion and were conducted face-to-face with all participants from the experimental group. With the participants' consent, an automatic video camera recorded all interviews, and the transcripts were created verbatim from these recordings. The interviews focused solely on participants in the experimental group, as the questions were specifically related to the program's implementation.

The researcher remained flexible, adjusting the order and details of the questions as needed. The duration of the interviews varied between 15 and 25 minutes. Despite this flexibility, the questions often involved comparisons. As Adams (2015) noted, the interviewer would sometimes restate what the participant had said in one or two sentences using the participant's own words. Additionally, interviewees were occasionally given time to think by allowing moments of silence. For longer questions, the interviewer would sometimes ask in a more explanatory manner.

Data Analysis

All interviews were transcribed verbatim using the audio recordings. To code inductively, the researcher and an external collaborator independently read all the transcripts to familiarize themselves with the data and gain a deep understanding. The open coding technique was used to generate initial open codes. Inductive coding is preferred because it allows codes, categories, and themes to naturally emerge from the data (Turk et al., 2021). The two researchers then compared their codes and descriptions from their independent analyses of the same transcripts. They developed a set of open codes to capture students' experiences with the program.

The researchers developed a codebook and continually updated and revised the codes and categories as new data emerged (Appendix J). The initial codes, created independently by the researchers, were compared for each case. They discussed and negotiated each case until they reached a 100% consensus, and these agreed-upon final codes were used for the qualitative data analysis. Patterns were identified in the data to develop themes guided by the research question. Following the guidelines suggested by Creswell and Poth (2018), the data were triangulated using multiple coders, including an external researcher, in the coding process.

Following Yin's (2018) recommendation, the researcher performed a cross-case analysis to explore and discuss the similarities and differences in participants' experiences with the program. This method involves collecting insights from individual case studies, enabling the researcher to compare and contrast these cases, thereby generating new knowledge. The researcher examined the cases regarding emerging themes, facilitating a comprehensive comparison across different instances.

Findings

Semi-structured interviews were conducted with nineteen 7th grade students in the experimental group in order to qualitative explore the effectiveness of the *Packaging Waste Recovery Education Program* (PWREP) and describe the participants' lived experiences with the program in terms of its effects on their knowledge, attitude, and behavior regarding environment in general and packaging waste recovery in particular. Most of the participants indicated that before participating in the PWREP, they did not know much about packaging waste recovery. For example, the students stated that they did not know the distinctions between plastic, metal, glass and paper waste before participating in the PWREP administered as part of this study. Similarly, some participants admitted that they did not even know that packaging waste could be recycled. In terms of their family members and their peers at school, most of the participants also indicated low or moderate levels of awareness and knowledge about packaging waste recovery, recycling, or other similar issues of recovery and environmental protection.

Overall, all of the participants described quite positive experiences with the program and reported having learned a great deal from the PWREP about the packaging waste recovery and the environmental protection. In alignment with their positive experiences with the PWREP, all the participants reported that they would definitely recommend the PWREP to their peers as they had so much fun learning about so many important things about waste recovery and the environment and believed that they could make this planet a better place to live in with more and more people becoming environmentally conscious and knowledgeable about recovery.

Major themes emerged as a result of inductive and deductive coding that would best represent the lived experiences of the participants with the PWREP in relation to its effects on their knowledge, attitude, and behavior regarding environment in general and packaging waste recovery in particular.

5.3.1. Gains in Knowledge about Packaging Waste Recovery

One major theme that emerged in the qualitative data of this study was gains in knowledge about packaging waste recovery, which actually manifested itself at a conceptual knowledge level and a procedural knowledge level.

5.3.1.1. Gains in conceptual knowledge about packaging waste recovery. Most of the participants indicated that they learned several specific concepts and terminologies associated with packaging waste recovery and recycling as a result of participating in the *Packaging Waste Recovery Education Program* (PWREP). The following excerpts are listed as evidence for gaining conceptual knowledge: P1 stated that before the PWREP, he did not know that "garbage" (çöp) and "waste" (atık) were two distinct concepts or terminologies used in relation to packaging waste recovery. Similarly, P2 indicated that she did not know such concepts as "disposure" (bertaraf), "burning" (yakma), and "energy recovery" (enerji kazanımı). Likewise, P3 stated that the program enabled him to learn about the conceptual distinction between "recovery" (geri kazanım) and "recycling" (geri dönüşüm). In a similar vein, most of the participants stated that participating in the PWREP also familiarized them with the symbols used to represent different terms or concepts associated with recovery and recycling, rendering them symbol-literate. For example, P7 explained that before participating in the PWREP, she did not know the "green dot" (yeşil nokta) icon and had never heard of CEVKO, the name of the foundation of environmental protection and packaging waste recovery in Turkey. P8 similarly stated that she had always confused those symbols on packages used to indicate different meanings in relation to recovery and recycling. She also admitted thinking that CEVKO only stands for "environmental protection" (çevreyi koruma) rather than for packaging waste recovery as well. Likewise, P9 stated, "I did not entirely know packaging wastes. I, for some reason, tended to think of nylon or plastic materials when I thought of packaging, but I learned about metal as well". As another example of conceptual knowledge gains, he also stated that he did not know anything about "composite waste" (kompozit atık) before participating in the program. All the other participants expressed similar learning experiences with the PWREP regarding gains in conceptual knowledge about packaging waste recovery. The program effectively bridged knowledge gaps, transforming the students from unawareness or misconceptions about key terminologies and symbols in waste management to a level of informed understanding.

5.3.1.2. Gains in procedural knowledge about packaging waste recovery. Most of the participants also indicated that participating in the *Packaging Waste Recovery Education Program* (PWREP)

provided them with the procedural knowledge regarding how recycling occurs, how recovery takes place, where medical waste is processed and so on. Their responses suggested that the PWREP helped eliminate several misconceptions about waste recovery and recycling processes. The following excerpts are listed as evidence for gaining procedural knowledge. P19 stated, “I thought fruit peel could be recycled, so could napkin. But it could not, I noticed that”. P18 stated, “Aircraft are made of plastic waste. I did not know it at all”. As another example of procedural knowledge gains in the program, P17 stated that before participating in the PWREP she had thought that all forms of waste, whether it be paper or packaging waste, were recycled in the same way. Similarly, P16 indicated that she had never thought that plastic or PET bottles could be recycled to produce soccer jerseys, a particular procedural knowledge gain about recovery and recycling that was commonly striking to most of the participants of the PWREP. Likewise, P14 stated that she did not know that it was possible, although difficult, to recycle wet materials, mistakenly believing that they should also be dumped as garbage. In a similar vein, it was surprising to P19 that fax paper could not be recycled. Overall, the participants’ experiences suggested that their participation in the program helped improve their procedural knowledge about packaging waste recovery and recycling as well as eliminate several misconceptions about the recovery and recycling process.

5.3.2. Gains in Environmentally Responsible Behavior and Attitude

Another major theme that emerged in the participants’ responses was associated with gains in environmentally responsive behavior and attitude, which actually manifested itself through individual behavior and attitude modification and peer behavior and attitude modification.

5.3.2.1. Individual behavior and attitude modification. Most of the participants agreed that their participation in the PWREP helped them change their old habits regarding environment and packaging recovery and indicated that the knowledge they gained from the program enabled them to act more environmentally responsibly in their daily routines. Some participants stated that after learning about packaging waste recovery and recycling in the PWREP, they started producing less garbage and less waste in their daily lives. P4, for instance, stated that before the program, she used to throw away unfinished notebooks and got new ones, but now after the program she still uses the notebook left from her fifth grade with a more environmentally-friendly attitude. One striking example of how the program fostered environmentally responsible behaviors in the participants was also explained by P4.

For example, before the program, I used to throw away all packaging waste, I mean the wastes, into garbage instead of putting them into recycling boxes. From now on, for example, I check the information on their back. I learn about the kind of the waste and more frequently put it into waste boxes.

As another example of producing less waste and garbage, P5 mentioned going to the school cafeteria much less and consuming much less plastic and paper products from the school cafeteria after the program. Similarly, P6 stated that she did her best to produce less waste by using paper more wisely and putting the paper and other packaging waste into waste boxes, not garbage bins. As another example of environmentally responsible individual behavior and attitude, P7 also stated that she saved plastic bags to reuse them in the future for different purposes rather than throwing them away into garbage bins after using them once. Similar experiences were also mentioned by the participants, which indicated that participating in the *Packaging Waste Recovery Education Program* (PWREP) yielded positive individual behavior and attitude modifications regarding environment protection and packaging waste recovery.

5.3.2.2. Peer behavior and attitude modification. The qualitative responses elicited from the participants regarding their experiences with the *Packaging Waste Recovery Education Program* (PWREP) suggested that the program also encouraged the students to modify their peers' behavior and attitude regarding environment protection in general and packaging waste recovery in particular. Some participants took active roles, after participating in the program, to kindly warn their peers to act more environmentally responsibly in their daily routines at school. For instance, P10 described an incident at their school dormitory where she kindly asked her peers to clean the eating area as it was dirty with garbage although it was not the garbage they themselves produced. She believed that such cleaning behaviors would also encourage others to follow suit and clean their own areas. The PWREP seemed to create such environmental care and sensitivity in the participants that prompted to take responsible actions in their own environments. For instance, P10 further explained:

> They [peers] used to put milk cartons into recycling box. Then, we together with our peers kind of started warning a couple of people. We also put warning texts around those recycling box areas…There is not so much waste now as before.

Overall, the participants' responses indicated that after participating in the program, the students started monitoring not only their own behaviors and attitudes towards waste recovery and

environment protection but also their peers' behaviors and attitudes to ensure less waste and garbage through more environmentally responsible behaviors. The program seemed to foster a sense of awareness and sensitivity across participants regarding environmental protection in general and packaging waste recovery in particular. However, in terms of peer behavior and attitude modification, some participants also admitted that it was still challenging to convince their peers to act responsibly although they knew that they should be doing so. For instance, P4 stated that her peers actually knew what they should be doing in terms of recovery and recycling but they expended no effort about it, indicating a lack of environmental sensitivity rather than knowledge.

5.3.3. Capacity to Offer Solutions to Environmental Problems

Another major theme that emerged in the participants' responses was associated with the capacity developed by the program participants to offer solutions to environmental problems they witnessed in their daily lives. P5 explicitly stated that she believed that her problem-solving skills developed significantly after participating in the program, which also helped her develop solutions to problems in her other courses at school. Using the knowledge and insights they acquired from the program, some participants also offered concrete solutions to waste recovery problems. For instance, P1 offered a design solution to the environmental problem of throwing away recyclables into garbage. He suggested installing big boxes with interesting designs to attract people's attention to recyclables and encourage them to consider putting their waste into recycling boxes rather than into garbage bins. Likewise, P7 recommended collaborative solutions regarding waste recovery and recycling to encourage partnerships among individual homes, municipalities, and researchers. Some participants like P9 recommended reusing waste materials to produce secondary products like soccer jerseys. On the other hand, P10 indicated that her participation in the program now helps her better think of a problem and its possible solutions. As she explained:

> Yes, it [participation in the program] helps because when looking for a solution you first think what you can do, whether it leads to negative or positive results when you do it, you have a question pop up on your mind. For instance, when you warn someone, you imagine how you should warn them.

Similarly, P11 agreed that her participation in the program contributed to her problem-solving skills regarding environment protection, explaining that the knowledge she gained from the program enabled her to better explain to others why they should put a waste into a recycling box rather than

into a garbage bin. The program seemed to provide the participants with the necessary insights and knowledge to better approach a problem situation and develop appropriate and creative solutions.

5.3.4. Sense of Responsibility and Emotional Concern about Environment

The final dominant theme that emerged in the qualitative data of the study was about a sense of responsibility and emotional concern about environment that the participants developed as a result of participating in the PWREP. Several participants expressed the positive impact of participating in the program on their environmental awareness and sensitivity towards environment and environmental issues including packaging waste recovery and recycling. For instance, P1 stated that he would immediately react to anything negative in his environment as he was more sensitive to environment than he had been before. P2 mentioned feeling emotionally so bad when there was leftover on her plate due to feeling a great sense of responsibility and emotional concern about the environment. As she further explained her emotional concern about the environment:

> For example, in the past I did not care when I saw trash on the ground. But now I do know what would happen if I did not put it into garbage bins or recycling boxes and I feel some kind of sorrow or sadness when I do not put it there. I now feel a sense of responsibility.

P4 expressed a similar emotional concern about environment by indicating that she felt weird and uncomfortable when she could not finish up the food on her plate, knowing it would go to garbage as trash if she did not eat it up. Similar emotional concerns about protecting the environment through waste recovery and recycling were commonly expressed by the participants in this study.

6. DISCUSSION

The study's intervention program was implemented during and after school. It is classified as a quasi-experimental design using control and experimental groups with a partial or total lack of random assignment. The control group was matched to the experimental group based on their Environmental Literacy (EL) levels. All students volunteered for the experimental group. The crucial question is whether the groups were initially comparable, and analysis revealed no statistically significant disparity in the pretest scores for EL between the experimental and control groups ($p = .9534$).

The total EL pretest scores are close, with no significant difference in the *Environmental Knowledge Test* (EKT), the *Packaging Waste Recovery Achievement Test* (PWRAT), the *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE), and the *Attitude Scale Towards Recovery of Packaging Wastes*. On the other hand, the *Children's Responsible Environmental Behavior Scale* (CREBS) scores are higher in favor of the control group, and the *Affective Disposition Toward Environment Scale* (ADTES) scores are higher in favor of the experimental group.

Post-intervention, a notable difference was observed between the pretest and posttest scores of the experimental group, with improvements across all scales. Although the control group saw some increases in scores (ADTES, EKT, Attitude Scale Towards Recovery of Packaging Wastes), scores on the PWRAT and PIPSSTE slightly decreased.

Upon reviewing the posttest results from the *Environmental Knowledge Test* (EKT), it was observed that the final scores for both the experimental and control groups showed a slight improvement compared to their respective pretest scores. Additionally, the increase in knowledge was found to be quite similar between the two groups. The intervention program was implemented concurrently with the conventional school program. Although environmental education is interdisciplinary, the intervention program specifically focused on recovery and waste management for six weeks. The EKT included a broad range of questions related to environmental issues, but only a limited number on recovery, which may not have been sufficient to significantly enhance the general environmental knowledge of the experimental group. Although Akçadağ and Çobanoğlu (2018) found no statistically significant difference in environmental knowledge between the groups, the

study suggests that the short-term nature of the intervention may have influenced this outcome. The researchers recommend incorporating outdoor education more extensively into the curriculum to enhance students' environmental literacy and promote sustainability. This alignment with broader findings suggests that while targeted interventions can enhance specific areas of knowledge, such as waste management, comprehensive and longer-term environmental education programs are necessary to achieve significant improvements across broader environmental literacy.

The *Packaging Waste Recovery Achievement Test* (PWRAT) and the *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE) analysis showed that the pretest scores of the control group were lower than their posttest scores. The cognitive load of the PIPSSTE may affect the students' concentration period in posttest implementation. Additionally, the pretests were taken by all 7th-grade students in parallel classes with the help of the school teachers in a more settled environment. That may affect the results of both groups in terms of taking into account the tests. Despite this, the posttest scores of students in the experimental group were notably higher than their pretest scores in PIPSSTE, suggesting an improvement in these skills.

According to the study's quantitative results, the study revealed a notable increase in students' environmental knowledge, as measured by the *Environmental Knowledge Test* (EKT), and in recovery, as measured by the *Packaging Waste Recovery Achievement Test* (PWRAT). The improvement in scores post-intervention indicates that the *Packaging Waste Recovery Education Program (PWREP)* effectively enhanced students' understanding of packaging waste recovery, aligning with the program's educational objectives. The students' opinions support it through the interviews. Students reported significant gains in conceptual and procedural understanding of packaging waste recovery, such as learning the difference between rubbish and waste, types of packaging waste, differentiating between recyclable and non-recyclable waste, and learning about different secondary products after recycling. They acquired specific terminologies and concepts related to waste recovery and learned about the practical aspects of recycling processes. This dual focus on conceptual clarity and procedural know-how is crucial for comprehensive environmental education.

The program also positively influenced students' attitudes toward the environment and recovery, as indicated by the *Affective Disposition Toward Environment Scale* (ADTES) and the *Attitude Scale toward Recovery of Packaging Wastes*. This shift suggests that the *Packaging Waste Recovery Education Program* (PWREP) succeeded in shaping students' perceptions and attitudes beyond

imparting knowledge, which is a critical component of fostering long-term environmental responsibility. From the qualitative data, several students expressed a newfound sense of responsibility and concern for environmental well-being. They articulated a deeper understanding of the consequences of unchecked waste production and the critical role of recovery and recycling in mitigating these effects. Their reflections on the subject revealed increased awareness and a transformation in how they emotionally connect with environmental issues. The study by Kaya (2019) similarly found that integrating socio-scientific issues into science education can enhance students' attitudes and behaviors toward environmental issues.

The *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE) results enhancing students' problem-solving skills in environmental contexts. With qualitative findings, the participants demonstrated an increased capacity to offer creative and practical solutions to environmental problems, a testament to the program's effectiveness in enhancing problem-solving skills. This ability to translate knowledge into action is pivotal for active environmental stewardship.

The *Children's Responsible Environmental Behavior Scale* (CREBS) results underscore the program's role in promoting environmentally responsible behavior. The increase in posttest scores reflects the practical applicability of the knowledge and attitudes instilled by the *Packaging Waste Recovery Education Program* (PWREP). The program led to meaningful changes in students' daily habits and perceptions regarding environmental protection and waste recovery. Students give examples of how they applied their learning to reduce and reuse packaging waste in their personal lives and influenced their peers, showcasing the program’s ripple effect in fostering a community-wide environmental consciousness through the interviews.

According to code segments, students’ views were respectively related to environmentally responsible behavior (23.3%) and knowledge gain about packaging waste recovery (19.00%) (Figure 6.1). This indicates that the PWREP increased students' environmental knowledge about packaging waste recovery and positively influenced their behaviors and problem-solving skills related to environmental issues. These findings support the call by Kışoğlu et al. (2010) for environmental education programs that go beyond knowledge transmission to include skill development and behavior modification.

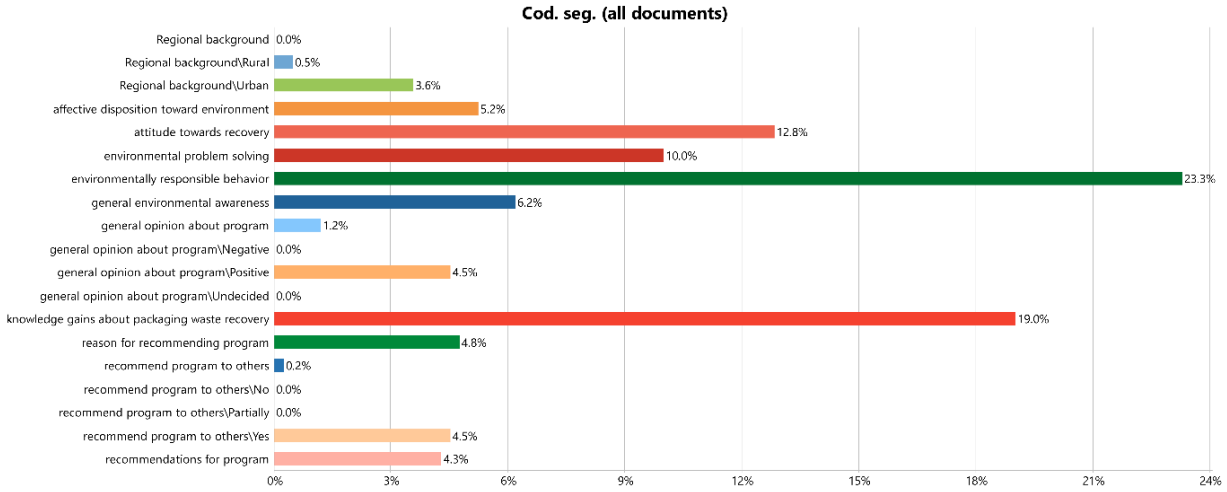

Figure 6.1. Code segments

The emotional aspect of environmental literacy was also prominent, with students expressing a heightened sense of responsibility and concern for environmental issues post-intervention. This emotional engagement is a powerful driver for sustained environmental action. Moreover, the interviews highlighted a shift in students' intentions regarding their behavior toward waste management. Students discussed their commitment to adopting more environmentally friendly practices, such as reducing waste, actively participating in recycling programs, and advocating for environmental issues within their communities. This shift in intention, from passive awareness to active participation, underscores the program's effectiveness in instilling a proactive and responsible environmental mindset. McBeth et al. (2014) found significant predictors identified from their study included verbal commitment, environmental sensitivity, general feelings toward the environment, and skills in identifying and analyzing environmental issues. Similarly, Zhu's (2015) findings identified perceived skills in citizen participation strategies, willingness to act (intention), and environmental sensitivity as the most influential predictors of environmentally responsible behavior (ERB). The current study has similar findings. Qualitative data from semi-structured interviews provided further evidence of the program's impact. Participants reported increased awareness and understanding of packaging waste recovery, changes in personal behaviors, and efforts to influence their peers' attitudes and actions. These qualitative findings underscore the importance of experiential and interactive learning approaches in environmental education, as advocated by previous studies (Negev et al., 2008; Chu et al., 2006).

Özbuğutu (2021) proposes further investigations into the specific methods and techniques for teaching environmental concepts within the identified curriculum. Building on this, Yazgan (2023)

suggests additional research on effective strategies to enhance practical environmental skills and responsible behaviors in educational curricula. In response to these recommendations, the current study aimed to develop the *Packaging Waste Recovery Education Program* (PWREP), which supports environmental literacy in various ways through project-based learning (PjBL). The results demonstrated that the PWREP significantly improved middle school students' environmental literacy, impacting their knowledge, attitudes, problem-solving skills, and environmentally responsible behavior (ERB). Qualitative data from semi-structured interviews provided more profound insights into the students' experiences and the program's influence on their conceptual and procedural knowledge, behavior, attitude, and problem-solving capacity. These findings underscore ongoing research's need to refine and expand such educational approaches to foster environmentally responsible student behavior.

7. CONCLUSION

The study includes developing and implementing an educational program on waste education based on waste hierarchy and recovery of packaging waste, as well as developing different types of instruments in the field of waste education. Waste and packaging waste are a part of our daily lives, not only for adults but also for students. Moseley (2000) says that a "review of the literature finds that most instructional techniques in the past have been based on environmental awareness and knowledge models" (p.24). On the other hand, more than awareness and knowledge is needed to take environmentally responsible action for the future of earth. The Berlin Declaration (UNESCO, 2021) highlighted the need to revolutionize education by diversifying teaching and learning methodologies, professional development, and community involvement. It underscored the significance of cultivating cognitive abilities, social and emotional competencies, teamwork capabilities, problem-solving skills, and adaptability. The Declaration and the associated conference accentuated the pivotal function of education in addressing worldwide environmental challenges and advocating for sustainable practices (UNESCO, 2021). Kaya and Elster (2019) pinpointed crucial topics that should be integrated into environmentally oriented curricula and textbooks. The researchers advocate for these subjects to comprehensively understand environmental concerns, practices promoting eco-friendliness, the fundamentals of environmental notions, strategies for tackling environmental issues, sustainability principles, and perspectives related to society. The project-based learning (PjBL) approach and studying packaging waste gave students opportunities to transfer their gains in knowledge, attitude, and skills into his/her daily lives. The PjBL model enhances students' problem-solving, scientific process, critical thinking, and creativity skills (Boncukçu, 2020).

In the current study, the students in the experimental group transferred the knowledge they gained into their daily routines and behaviors and affected their peers. While knowledge and understanding are critical elements of environmental literacy, they don't fully capture its essence. Studies indicate frequent mismatches between individuals' knowledge and actions (NEEF, 2015). Indeed, a range of other elements — including emotions towards the environment, personal experiences with nature, societal norms, individual priorities, capabilities, and personal identity, among others — influence whether people act on their environmental knowledge. (NEEF, 2015).)

NEEF (2015) defines an environmentally literate individual is as a person who makes well-informed choices about environmental matters, both independently and collaboratively. This person

is prepared to take action based on these decisions to enhance the welfare of others, society at large, and the global environment. Additionally, they are actively involved in community and civic activities. The study focused on developing environmentally literate students and the program developed in the study based on not only gaining knowledge but also from more holistic view including problem solving skills, responsible behaviours towards environment.

This study has several strengths, such as the inclusion of two groups, which facilitates comparative analysis, and the implementation of pre and post-tests that enhance the robustness of the comparisons between groups.

Four instruments, such as the "*Environmental Knowledge Test* (EKT)", the "*Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE), the "*Packaging Waste Recovery Achievement Test* (PWRAT)" and the "*Attitude Scale Towards Recovery of Packaging Wastes*" were developed by the researcher. Besides that, two scales, the "Children's *Responsible Environmental Behavior Scale* (CREBS)" and the "*Affective Disposition Toward Environment Scale* (ADTES)," were adopted for middle school students by the researcher. Additionally, the research's robustness is augmented by its methodological diversity; it does not solely rely on quantitative analysis. Semi-structured interviews were conducted with experimental group members to gain a deeper understanding.

As with other research, the study also has some limitations. This study was designed as quasi-experimental research. The school was not selected randomly. It was selected since the researcher works there. Although sex distribution was similar for the control and experimental groups, there were differences in the total numbers of female and male students in general; the rate of female students in the control group was 73.7%, and the rate was 78.9% for the experimental group. Similarly, the rate of male students in the control group is 26.3%, and the rate in the experimental group is 21.1%. Some part of the intervention program was applied on Wednesdays and Fridays. Although the students decided on the dates, attendance of the students might vary in some periods due to studying for exams, the high amount of extra circular activities after school, and their emotional needs to go out because of their boarding status. Although the total amount of the program did not change, some lessons were postponed due to the number of participants.

The study sample was selected conveniently. The study occurred in a boarding school supported by deceased fathers and/or mothers by a foundation in Istanbul, where the researcher works. All

students whose families are in financial hardship come from different provinces of Turkey. According to students' statements, six mothers and six fathers out of 38 students in the control and experimental group are university graduates. Parents are not highly educated, and most mothers are housewives. Akıllı and Genç (2015) investigated the environmental literacy of middle school students in terms of various variables. They conducted a study with 713 students from eight schools in Düzce and Bartın, Turkey. Significant differences were found in the sub-dimensions of environmental literacy based on the educational levels of fathers. As fathers' education levels increased, there was a significant increase in environmental knowledge, tendency, behavior, and attitude sub-dimensions. In contrast, mothers' education levels did not show the same pattern. Students with mothers who were high school graduates had significantly different scores compared to others. Since the number of experimental and control groups is small, the findings may not be generalizable to a broader population without further studies that include a more extensive and diverse sample.

To increase the generalizability of the study, it should be replicated with students in different types of schools and from different locations and implemented in the science lesson in middle school and possibly in primary school. Since there are related objectives with recovery and recycling in 7th-grade or 8th-grade science, the program can be adapted by adding some approaches in prevention of the waste to conventional teaching that causes fewer attendance problems as well. To adopt the program into conventional teaching, teacher training is also crucial. It is also essential for broadening the adoption of project-based learning (PjBL) as well as the quality of the program. Focusing on equipping teachers with the necessary skills is a more sustainable approach compared to relying solely on isolated studies where researchers also serve as the implementers (Doğança, 2013).

Yazgan (2023) suggests further research on effective strategies to enhance practical environmental skills and responsible behaviors in educational curricula. This study can be adopted into after-school programs such as eco-school and global school programs. After-school programs give opportunities for teachers from other disciplines suitable for the nature of environmental education and sustainable development goals. Environmental education's core goal is teaching environmental literacy (NAAEE, 2019). To achieve this goal, it is essential that environmental literacy is prioritized as a key focus in K-12 education and beyond.

Some suggestions are listed for further studies:

1. Enhancing environmental education through activities conducted outside the classroom allows students to witness different environmental scenarios firsthand (Derman & Gürbüz, 2018). Because of the limited time and legal permissions, the recycling field trip during the intervention program could not happen. When formulating curricula/programs, those who design these educational plans should integrate an adequate number of field excursions, investigative tasks, and projects. Such incorporation aims to provide students with the necessary knowledge and skills to address environmental issues effectively (Olatundun & Adu, 2013).

2. In the current study, the students mentioned the misconceptions related to waste and packaging waste they have. The root of the misconceptions should be examined through the school textbooks and teachers.

3. The school textbooks and related children's books, specially prepared for early ages, can be examined regarding waste hierarchy and recovery approach. Palmer et al. (2013) identified a significant gap: the need for more targeted educational materials and programs that address these misconceptions and effectively teach young children about waste management and recycling processes. This highlights a broader need for research on effective teaching strategies and curricular development for environmental education in early childhood settings.

4. Project-based learning is one of the active teaching and learning methods. It offered students participation in designing their project as well as proceed it. Education for Sustainable Development is expected to be learner-centered, transformative and action-based (Leichts et al., 2018). Diversifying teaching methodologies (Derevenskaia, 2014), advocating for outdoor and problem-based learning (Arık & Yılmaz, 2020), and a system thinking approach can be applied to waste education to deepen students' environmental understanding and attitudes.

5. The current study was implemented for six weeks and 12 sessions. Studies often focus on short-term changes in knowledge and behavior (Damerel, 2013). Longitudinal studies suggested assessing environmental education's long-term impact on behavioral changes and literacy (Coyle, 2005; Hollweg et al., 2011) on recovery and waste management. It is also suggested that the long-term sustainability of the changes in behavior, especially post-

educational intervention, be examined (Damerel, 2013). There can be post-interviews in three/six months after program completion.

6. There should be more priority in preschool on environmental education, including packaging waste, which is a part of daily life, and the 3Rs, the waste hierarchy. Kahriman-Ozturk et al. (2012) explored the concepts of sustainable development and the 7Rs (Reduce, Reuse, Respect, Reflect, Rethink, Recycle, Redistribute) among preschool children. The study investigates how these young children understand and perceive the three pillars of sustainable development: Environmental, Economic, and Social-Cultural. Using a qualitative research approach, the study involved 36 preschoolers from different schools in Ankara, Turkey. The findings showed that children were familiar with reducing, reusing, recycling, and respecting but needed more understanding of reflecting, rethinking, and redistributing. The research underscores the importance of early childhood education in shaping attitudes and behaviors toward sustainability. Integrating sustainable practices into early childhood education can enhance children's understanding and engagement with these concepts. One neglected research area highlighted by the study is the need for a more in-depth exploration of how different educational methods and materials can effectively convey more abstract sustainability concepts, like reflect, rethink, and redistribute, to young children. Additionally, the study opens avenues for further research into the long-term effects of early sustainability education on children's attitudes and behaviors.

Palmer et al. (2013) identified a significant gap: the need for more targeted educational materials and programs that address these misconceptions and effectively teach young children about waste management and recycling processes. This highlights a broader need for research on effective teaching strategies and curricular development for environmental education in early childhood settings.

According to the current study's qualitative data, "teachers" were the primary sources for students to receive information about the environment and nature for the control and experimental groups. Teacher training on waste management and waste recovery is essential not only for knowledge base but also in improving attitude and behavior changes.

Cinquetti and Carvalho (2007) examine the learning and teaching processes about solid waste in Brazilian elementary schools. The focus is on professional development courses and school-based

meetings for teachers, analyzing their reflections on environmental education's three dimensions: knowledge, values (ethical and aesthetic), and political participation. The study identifies which dimensions are predominant or absent in teachers' projects, highlighting issues relevant to supporting teacher education and curriculum programs. This research contributes insights for developing more critical and practical educational projects on solid waste management. Specifically, researchers aimed to determine which aspect needed improvement and which was improved. Teachers perceived the knowledge dimension of environmental themes, the most evident of the three dimensions, as a challenge requiring development, attention and effort. Many teachers exhibited advanced levels of reflexivity in presenting their knowledge and perspectives. While aspects of political participation were present in some teachers' projects, they were less common than the knowledge dimension. Notably, the values dimension posed the most significant difficulties for teachers, with its relative absence in projects and a prevalence of ethical approaches as a code.

As a result, it is crucial to challenge the idea that knowledge or information alone drives learning and teaching about environmental topics. The often-overlooked dimensions of values and political participation require attention from teacher educators and teachers to conceptually clarify and explore ways to integrate them into their pedagogical practices. This does not reduce the importance of knowledge but instead highlights the necessity for educators to address these additional dimensions. Please do so to ensure these aspects are addressed in environmental education.

7. Preventing and reducing waste is crucial for the earth. There should be more focus on these approaches besides recovery. Cinquetti and Carvalho (2007), concerning teachers' education, the significance of the 3Rs principle appeared pivotal in shaping teachers' perceptions. It played a crucial role in challenging the dominance of recycling and distinguishing between recycling and reuse. Besides that, although waste and packaging waste are popular, there might be some knowledge gaps among teachers, as Cinquetti and Carvalho (2007) mentioned. Harman and Çelikler (2016) investigated the recycling awareness of 315 student teachers in the Department of Science Education in Turkey using five open-ended questions. They found that while the student teachers were familiar with recycling and understood its purpose and importance, they lacked knowledge about which materials could be recycled. This finding highlights an issue with participation levels. Consequently, they identified a gap between the practical and theoretical aspects of teacher education.

Several studies have shown that student teachers are familiar with recycling. For instance, primary-level student teachers outlined the responsibilities of individuals and administrators in environmental protection during interviews (Kahyaoğlu & Kaya, 2012). Chemistry student teachers emphasized the importance of using recyclable materials, particularly in industries (Yücel & Morgil, 1998). Geography student teachers viewed recycling as a global activity (Kocalar & Balcı, 2013). However, mere awareness is insufficient; the literature highlights the need to address theoretical and practical gaps in teacher education.

Waste is a human product that lives long in nature without composting. On the other hand, there is no rubbish or waste in the cycle of nature. The anthropocentric view was that the earth was to be destroyed. Environmental ethics and sharing the planet with others should be included in all student programs and materials and teacher training programs. In addressing the prevalence of anthropocentric and utilitarian approaches, Cinquetti and Carvalho (2007) identify this as a significant challenge in environmental education, particularly in teaching and learning about solid waste. The absence of considerations regarding the impacts on the environment or all living beings, not solely humans, was observed in teachers' projects and the reference materials and didactic resources they utilized. In educational programs focused on solid waste, it is crucial to emphasize the consequences of improper garbage disposal and the limitations and environmental impacts of goods production and recycling, which extend beyond human health to encompass the well-being of other living beings and the broader environmental ecosystem.

The qualitative responses elicited from the participants regarding their experiences with the PWREP suggested that the program also encouraged the students to modify their peers' behavior and attitude regarding environment protection in general and packaging waste recovery in particular. Schools are the primary social environment for students, especially after the COVID-19 pandemic. Schools should be reorganized to support students' sustainable habits towards waste and packaging waste in terms of waste management and recovery. Redman (2013) emphasizes the significant role of social environments, particularly schools, in fostering and sustaining behavior change toward sustainability. Schools are crucial in creating an environment supportive of sustainable habits, often more influential than the role of parents or guardians due to the extensive time students spend at school. It underscores the necessity of integrating sustainable practices into educational strategies beyond technical and informational teaching. Recognizing that future challenges demand a widespread shift to sustainable behaviors, the study aligns with UNESCO's 1997 declaration that education is critical to addressing future challenges (UNESCO, 1997).

Since the school where the research was implemented was a boarding school, parent and student interaction may be observed less. The effect of parents' knowledge, attitude, and behavior should be examined in student behavior change for further studies. The study by Damerell (2013) explores the impact of environmental education (EE) on children and their parents. It is notable for using quantitative data to establish a causal relationship between EE aimed at children and subsequent behavior change in conservation practices at the household level. The research demonstrates that EE can significantly alter children's understanding and behaviors regarding the environment and positively influence their parents' knowledge and actions. This suggests that educational strategies can effectively target children and adults, highlighting the potential for EE to have a cross-generational impact. Damerell's work contributes to the evidence of the bidirectional influence between children and parents in environmental education. It underscores the need for long-term, family-inclusive approaches to foster sustainable behavioral changes. As agents of change, children can extend the impact of educational interventions beyond the classroom, influencing broader societal environmental conservation efforts. From this point, understanding how environmental education in children can influence adult behavior and knowledge in the long term can be explored in terms of waste education.

Highlighting the importance of environmental education in addressing environmental issues and the necessity for teachers and teacher candidates to develop strong environmental awareness and inform widespread about the good examples is crucial. Kaya and Elster (2019) emphasized that families and teachers are crucial in informing children about environmental issues, promoting positive attitudes toward the environment, and guiding environmentally friendly behavior. Initiated in 2017 by Turkey's Ministry of Environment and Urbanization, the Zero Waste Project is a sustainable development initiative aimed at waste management and creating a cleaner environment for future generations. The project's goals include minimizing waste generation, efficiently using natural resources, segregating waste, recycling, and contributing to the economy through waste management practices. Yüzüak and Erten (2022) present an insightful study on the perceptions and knowledge of teachers regarding Turkey's Zero Waste Project. Conducted during the 2019-2020 academic year, it involved 126 teachers from various disciplines across primary and secondary public schools in Turkey. Using qualitative data techniques and semi-structured interviews, the study found that many teachers were not well-informed about the project despite its four-year implementation.

The escalating problems associated with the growing volume of waste underscore the necessity of waste management practices focused on minimizing or eliminating waste production and

consumption (*MoEUCC*, 2017). Recent news about revised curricula for k12 education for all subject matters was disseminated in December 2023. Curriculum objectives related to waste should be organized according to waste hierarchy and spread according to different cognitive levels (Cabbar et al., 2020) on waste and skills and attitude oriented.

Öz-Aydın et al. (2002) revealed that about half of the curriculum's objectives are knowledge-based, primarily emphasizing ecological foundations. It points out the need for more focused research on higher-level environmental education objectives in Turkish curricula, especially in participation, skills development, and addressing complex environmental issues. Yazgan (2023) examined how environmental literacy changed in science education between 1992, 2006, 2013, and 2018, in environmental education in 2015, and in environmental education and climate change courses in 2022 were compared according to years. The research discovers that knowledge components are most frequently represented. Despite these findings, when examining studies on environmental knowledge, it is observed that primary school students' understanding of the environment is not at a sufficient level, as indicated by research conducted by Ökeşli (2008) and Varışlı (2009). With similar findings, Koto (2020) conducted a study focusing on the assessment of environmental education within the 2018 primary school curricula of both Turkey and Ontario, Canada. It has been identified as the pressing need for a more in-depth exploration of how environmental education can be effectively integrated into primary education, specifically focusing on developing skills and active engagement in environmental issues. It is essential for environmental literacy. Students in international assessments like PISA and TIMSS often struggle with interpreting questions due to a lack of higher-level cognitive skills. This deficiency leads to subpar performance rankings for the country. This situation suggests issues in converting the curriculum's objectives into effectively learned knowledge (Cabbar et al., 2020). The new curricula should be designed to include knowledge, attitudes, skills, behaviors, and environmental understanding.

7.1. Environmental Significance of the Study

This study underscores the critical role of targeted educational programs in advancing environmental science and literacy among middle school students. The Packaging Waste Recovery Education Program (PWREP) was designed to address gaps in environmental knowledge, attitudes, and behaviors. By focusing on packaging waste recovery, the program offers a model for integrating practical environmental education into school curricula. This approach enhances students'

understanding of waste management and empowers them with the knowledge and skills needed to tackle broader environmental challenges.

The study's findings reveal significant gains in students' environmental literacy, as evidenced by improved scores across multiple scales, including the *Environmental Knowledge Test* (EKT) and the *Packaging Waste Recovery Achievement Test* (PWRAT) (Jones & Barker, 2015). These results highlight the program's effectiveness in promoting an understanding of critical environmental concepts, such as waste hierarchy, the distinction between recyclable and non-recyclable materials and the processes involved in recovery/recycling. By providing a comprehensive education that combines conceptual clarity with practical skills, the PWREP contributes to a more informed and engaged generation of students ready to address complex environmental issues.

A significant outcome of the PWREP is the promotion of environmentally responsible behaviors among students. The study's results, particularly the improvement in scores on the Children's Responsible Environmental Behavior Scale (CREBS) and the Affective Disposition Toward Environment Scale (ADTES), demonstrate a positive shift in students' attitudes toward the environment. This shift is crucial for fostering long-term sustainability, as attitudes are critical predictors of behavior change.

Students participating in the program reported increased motivation to reduce waste, recycle, and adopt more sustainable practices in their daily lives. This change is not limited to individual behavior; the program also fostered a sense of environmental stewardship that extends to influencing peers and family members. The PWREP's success in cultivating environmentally conscious behaviors highlights its significance in promoting sustainable living and its potential to create a ripple effect of positive environmental change within communities.

The study also emphasizes developing students' problem-solving skills in environmental contexts. The improvements in the *Problem Identification and Problem-Solving Skills Test Towards Environment* (PIPSSTE) suggest that the PWREP effectively enhances students' ability to analyze and address environmental challenges. By engaging students in project-based learning and real-world problem-solving activities, the program empowers them to translate knowledge into action.

This capability is vital for active environmental stewardship, as it equips students with the skills to identify environmental issues, develop innovative solutions, and implement effective strategies for

change (Buzkan & Erman, 2020). By fostering critical thinking and creativity, the PWREP prepares students to contribute positively to environmental science and sustainability efforts in their communities and beyond.

The PWREP has also been instrumental in fostering emotional engagement and a sense of responsibility toward environmental issues among students. The program's focus on experiential learning has helped students develop a deeper emotional connection to environmental protection and waste management, driving them to take proactive steps toward sustainability.

The qualitative findings from the study reveal that students expressed a heightened sense of responsibility and concern for environmental well-being. They articulated a deeper understanding of the consequences of unchecked waste production and the critical role of recovery and recycling in mitigating these effects. This emotional engagement is a powerful driver for sustained environmental action, underscoring the importance of integrating affective elements into environmental education (Moseley, 2000).

The findings of this study have significant implications for environmental science, particularly in environmental education. By demonstrating the effectiveness of targeted educational interventions, such as the PWREP, the study provides a blueprint for developing programs that enhance environmental literacy and promote sustainable behaviors (Leicht et al., 2018). Furthermore, the study highlights the importance of incorporating values, political participation, and emotional engagement into environmental education. These dimensions are often overlooked but are crucial for fostering a holistic understanding of environmental issues and empowering individuals to take meaningful action (Ellen MacArthur Foundation, 2015).

In conclusion, the *Packaging Waste Recovery Education Program* exemplifies how structured educational interventions can significantly impact students' environmental literacy, behavior, and problem-solving skills. This study contributes to the growing body of research advocating for comprehensive environmental education that equips future generations with the tools needed to navigate and address the complex challenges of environmental science and sustainability.

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APPENDIX A: LIST OF THE RESEARCHERS AND THE NUMBER OF QUESTIONS USED IN THE DRAFT OF ENVIRONMENTAL KNOWLEDGE TEST

Researcher	EKT Part 1	EKT Part 2	Total
Alibeyoğlu (The researcher)	8	6	14
(Altınöz, 2010)	1	0	1
(Aydemir, 2007)	4	2	6
(Benzer, 2010)	0	1	1
(Bildik, 2011)	0	1	1
(DPY, 2011)	0	1	1
(Erdoğan, 2009)	1	0	1
(Krnel, 2009)	1	0	1
5th Grade Science and Technology Textbook	1	0	1
(Ökeşli, 2008)	0	1	1
(Öztürk, 2010)	1	0	1
SBS (2002-2011)	4	5	9
(Selvi, 2007)	0	1	1
(Serenli, 2010)	0	1	1
(Solmaz, 2007)	0	2	2
(West, 2007)	2	2	4
Total	23	23	46

APPENDIX B: CONCEPTS DISTRIBUTION IN THE DRAFT OF ENVIRONMENTAL KNOWLEDGE TEST

Concepts	Test 1	Test 2	Total
Acid rain/ Asit yağmurları		3	1
Food chain/ Besin zinciri	8, 9, 11	21	4
Biological diversity/ Biyolojik çeşitlilik	2, 4		2
Environment, environmental problems/ Çevre, çevre sorunları	1, 3, 6, 24		4
Environmental protection/ Çevre koruma		20	1
Ecosystem/ Ekosistem	7	10	2
Energy/ Enerji	19, 20, 21	24	4
Erosion/ Erozyon		13	1
Genetic biotechnology/ Genetik biyoteknoloji		11	1
Recovery, recycling, waste management/ Geri kazanım, geri dönüşüm, atık yönetimi	16, 17	4, 5, 6, 7, 8	7
Air pollution/ Hava kirliliği		1	1
Light pollution/ Işık kirliliği	23		1
Chemical pollution/ Kimyasal kirlilik		12	1
Global warming/ Küresel ısınma		14,15, 19	3
Depletion of Ozone layer/ Ozon tabakasının delinmesi		16, 17	2
Population/ Popülasyon	12, 13, 14, 15		4
Greenhouse affect/ Sera etkisi		18	1
Noise pollution/ Ses kirliliği	22		1
Water and water pollution/ Su ve su kirliliği	18	9	2
Soil and land use/ Toprak ve alan kullanımı		22, 23	2
Habitat degradation/ Yaşam alanı tahribatı	5		1
Total	23	23	46

APPENDIX C: ENVIRONMENTAL KNOWLEDGE TEST

ÇEVRE BİLGİSİ TESTİ

Değerli öğrencimiz,

Bu anket, sizlerin çevre ile ilgili sahip olduğunuz bilgileri belirlemek amacıyla hazırlanmıştır. Anket, iki bölümden oluşmaktadır. Her bölümün başında, o bölümle ilgili kısa bir açıklama yer almaktadır. Ankete vermiş olduğunuz yanıtlar gizli tutulacaktır. Anketlerin üzerine isminizi yazmanıza gerek yoktur. Elde edilen bilgiler sadece araştırma amaçlı kullanılacağı için vereceğiniz yanıtlar çok önemlidir. Araştırmanın sağlıklı sonuç vermesi için ankette yer alan her bir sorunun yanıtlanması önemlidir. Çalışmaya katıldığınız için teşekkür ederim.

Meltem Ceylan Alibeyoğlu
Boğaziçi Üniversitesi Çevre Bilimleri Enstitüsü

BÖLÜM 1. KİŞİSEL BİLGİLER

Bu bölümde yer alan 25 soru, sizinle ilgili bazı kişisel bilgileri belirlemeye yöneliktir. Lütfen her bir soruyu dikkatlice okuyunuz ve size uygun olan seçeneği (x) ile işaretleyiniz. Boş bırakılan yerlere sizden istenilen bilgileri yazınız.

1. Adınız ve soyadınız:…….

2. Öğrenim görmekte olduğunuz okulun tam adı:……

3. Okulunuz :( ) Devlet Okulu ( ) Özel Okul

4. Cinsiyetiniz : ( ) Kız ( ) Erkek

5. Doğum tarihiniz (Gün/Ay/Yıl) : ……../……./……

6. Sınıf ve şubeniz : ……Sınıfı …….Şube

7. Anaokuluna/kreşe gittiniz mi?

( ) Evet ( ) Hayır

8. Babanızın eğitim durumu

( ) Bilmiyorum ( ) Okuryazar değil ( ) İlkokul mezunu ( ) Ortaokul mezunu
( ) Lise mezunu ( ) Üniversite mezunu ( ) Yüksek Lisans/Doktora

9. Annenizin eğitim durumu

( ) Bilmiyorum ( ) Okuryazar değil ( ) İlkokul mezunu ( ) Ortaokul mezunu
( ) Lise mezunu ( ) Üniversite mezunu ( ) Yüksek Lisans/Doktora

10. Babanızın mesleği :…….

11. Annenizin mesleği :…….

12. En uzun yaşadığınız yerleşim birimi ( ) Köy ( ) Kasaba ( ) İlçe ( ) İl

13. Çevre ve doğaya ilişkin olaylarla ne kadar ilgileniyorsunuz.

( ) Hiç ilgimi çekmiyor ( ) Pek az ilgileniyorum ( ) Zaman zaman ilgileniyorum
( ) Oldukça çok ilgilenirim ( ) Çok ilgili ve meraklıyım

14. Aşağıda yer alan kaynaklardan hangisi veya hangileri çevre ve doğa ile ilgili bilgi sahibi olmanıza yardımcı oluyor? (Birden fazla seçenek işaretleyebilirsiniz.)

( ) Öğretmenlerim ( ) Arkadaşlarım ( ) Ailem ve akrabalarım
( ) İnternet ( ) Ders kitapları, gazete ve dergiler ( ) Dersler
( ) Çevre ile ilgili kitaplar ( ) Seyrettiğim televizyon programları (Belgesel vb.)
( ) Çevre için çalışan dernek ve kulüpler
( ) Kendi kişisel gözlemlerim ( ) Diğer (belirtiniz)…….

15. Yakın aile bireylerinizin çevre ve çevre sorunlarına karşı duyarlılıkları konusunda ne düşünüyorsunuz?

( ) Çok duyarlılar ( ) Oldukça duyarlılar ( ) Duyarlı sayılabilirler
( ) Yeteri kadar duyarlı değiller ( ) Kararsızım

16. Yakın aile bireylerinizin çevreyi korumaya yönelik davranışları konusunda ne düşünüyorsunuz?

( ) Çok etkinler ( ) Biraz etkinlik gösteriyorlar ( ) Hiç etkin değiller ( ) Kararsızım

17. Öğretmenlerinizin çevreye karşı duyarlılıkları konusunda ne düşünüyorsunuz?

( ) Çok duyarlılar ( ) Oldukça duyarlılar ( ) Duyarlı sayılabilirler

( ) Yeteri kadar duyarlı değiller ( ) Kararsızım

18. Okul idaresinin çevreye karşı duyarlılığı konusunda ne düşünüyorsunuz?

( ) Çok duyarlı ( ) Oldukça duyarlı ( ) Duyarlı sayılabilir

( ) Yeteri kadar duyarlı değil ( ) Kararsızım

19. Bir hayvan yetiştirdiniz/yetiştiriyor musunuz ya da sorumluluğunu bir süre üstlendiniz mi?

( ) Evet ( ) Hayır

20. Bir bitki yetiştirdiniz/yetiştiriyor musunuz ya da sorumluluğunu bir süre üstlendiniz mi?

( ) Evet ( ) Hayır

21. Etkinliklerini takip ettiğiniz -çevre ile ilgili- bir kurum varsa belirtiniz: .....

22. Okul içerisinde veya dışında çevre ile ilgili gerçekleşen bir etkinlikte/projede (Araştırmacı Çocuk'ta çevre ile ilgili bir araştırma, Çevre Kulübü vb.) görev aldıysanız belirtiniz: **…….**

23. Çevre veya çevre eğitimiyle ilgili okul içinde veya dışında herhangi bir seminere veya eğitime katıldıysanız belirtiniz**: ……..**

24.Çevre konuları hakkındaki bilgi seviyenizi nasıl tanımlıyorsunuz?

( ) Çok iyi ( ) Yeterli ( ) Yetersiz ( ) Hemen hemen hiç

25. Okul içerisinde çevre ile ilgili gerçekleşecek bir etkinliğe/projeye katılmaya gönüllü olur musunuz?

( ) Zaten çok istekliyim

( ) Fırsat çıkarsa katılırım

( ) Koşullar uygun olursa katılırım

( ) Hiç istekli değilim

ENVIRONMENTAL KNOWLEDGE TEST PART 1

ÇEVRE BİLGİSİ TEST BÖLÜM 1

Açıklama: Bu bölümde çoktan seçmeli toplam 17 soru yer almaktadır. Bu sorular sizlerin çevre ile ilgili sahip olduğunuz bilgileri ortaya çıkarmak amacıyla hazırlanmıştır. Her sorunun bir doğru cevabı vardır. Yanlışlar doğruları **götürmemektedir.** Anket sonuçları herhangi bir not ile değerlendirilmeyecektir. Sonuçlar sadece araştırmacılar tarafından kullanılacaktır. Yanıtsız bir soru **bırakmamanız**, yapılan araştırma sonuçları için çok önemlidir.

1) Aşağıdaki tabloda bazı canlılar ve yaşadıkları alanların özellikleriyle ilgili bilgiler verilmiştir. 1, 2 ve 3 numaralı boşluklara gelmesi gereken kelimeler tablonun altında yer alan hangi seçenekte **doğru** verilmiştir?

Canlı	Yaşadığı alanın özelliği
1.....	Kurak
Penguen	**2.....**
3.....	Nemli toprak

	1	**2**	**3**
A)	Timsah	Soğuk	Sincap
B)	Yılan	Soğuk	Kaktüs
C)	Akrep	Sıcak	Timsah
D)	Kaktüs	Soğuk	Solucan
E)	Söğüt	Sıcak	Kurbağa

F) Bilmiyorum

2) Aşağıdaki ortamlardan hangisi, yeryüzündeki bitki ve hayvan türlerinin %80'nini barındırma özelliğiyle **en fazla** canlı çeşitliliğine sahiptir?

A) Bozkırlar

B) Yaprak döken ormanlar

C) Yağmur ormanları

D) İğne yapraklı ormanlar

E) Makiler

F) Bilmiyorum

3) Aşağıdakilerden hangisi **çevre sorunu** olarak **düşünülmez**?

A) Erozyon

B) Düzensiz kentleşme

C) Ormansızlaşma

D) Çölleşme

E) Deprem

F) Bilmiyorum

4) Aşağıda verilen canlılardan hangisinin nesli ülkemizde **tükenmiştir**?

A) Meşe B) Nilüfer C) Denizanası D) Leopar E) Leylek F) Bilmiyorum

5) Aşağıdaki eşleştirmelerden hangisinde hayvanların beslenme şekilleri **doğru** verilmiştir?

A) Geyik - Hem otobur hem etobur

B) Kurbağa - Otobur

C) Deve - Etobur

D) Güvercin - Etobur

E) Leopar - Etobur

F) Bilmiyorum

6) Aynı türdeki büyük bir grup hayvanı yeni bir ortama taşıdığımızda **ne olur**?

A) Biyolojik çeşitliliğe yarar sağlarız.

B) Besin zincirini zenginleştiririz.

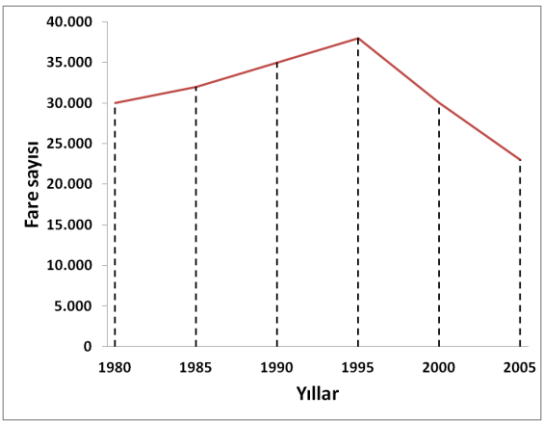
C) Çevre kirliliği yaratırız.

D) Besin zincirinde bir değişim yaratmayız.

E) Ekolojik dengeyi olumsuz etkileriz.

F) Bilmiyorum.

7) Fare, yılanlar için bir besin kaynağıdır. Yılan sayısı aynı kalmak koşuluyla yandaki grafikte yıllara göre fare sayısı verilmiştir. Bu grafiğe göre yılanlar arasında besin için rekabetin **<u>en az</u>** olduğu yıl aşağıdakilerden hangisidir?(Not: Fare, yılanlar için tek besin kaynağıdır.)



A) 1985
B) 1990
C) 1995
D) 2000
E) 2005
F) Bilmiyorum

8) Aşağıda bir bölgedeki besin zinciri verilmiştir. Bu bölgede, belli bir keklik türü insanlar tarafından bilinçsizce avlanmıştır. Bunun sonucunda sayıları aşırı şekilde artan tırtıllar, orman ve ekili alanlara zarar vermiştir. Bu bölgede, tırtıl sayısındaki artışın kontrol altına alınıp **<u>önceki doğal dengenin</u>** yeniden sağlanabilmesi için aşağıdakilerden hangisi önerilebilir?

Keklik → ***Tırtıl*** → ***Bitki***

A) Tırtılla beslenen başka tür hayvanların getirilmesi.
B) Uygun sayıda aynı türden keklik getirilmesi.
C) Tırtılların beslendiği bitkilerle beslenen başka tür hayvanların getirilmesi.
D) Tırtılların beslendiği bitkilerin yok edilip farklı tür bitkilerin ekilmesi.
E) Tırtıl sayısını azaltmak amacıyla kimyasal ilaç kullanılması.
F) Bilmiyorum.

9) Bir besin zincirinde kullanılan enerjinin **<u>ilk kaynağı</u>** aşağıdakilerden hangisidir?
A) Yaprak
B) Güneş
C) Topraktaki mineraller
D) Topraktaki su
E) Oksijen
F) Bilmiyorum

10) Belirli bir bölgede yaşayan; birbiriyle üreme yeteneğine sahip, ortak atadan gelen benzer özellikteki organizmalara ait bireyler topluluğuna popülasyon denir.

Ayşe: Göldeki ördekler *bir popülasyondur ancak göl kenarındaki bitkiler bir popülasyon belirtmez. Çünkü popülasyon…*

Buna göre, aşağıdakilerden hangisi Ayşe'nin açıklamasını tamamlar?

A) Gölde yaşayan canlılardan oluşur.

B) Aynı tür canlılardan oluşur.

C) Sadece hayvanlardan oluşur.

D) Hem karada hem suda yaşayan canlılardan oluşur.

E) Sadece bitkilerden oluşur.

F) Bilmiyorum.

11) 21.yüzyılda yaşadığımız dünya önemli sorunlarla karşı karşıyadır. Özellikle dünya nüfusunun hızlı artışı ekonomik, sosyal ve çevresel sorunlara yol açmıştır. Buna göre, aşağıdakilerden hangisi nüfusu artışı ile ilgili **doğrudan** bir sorun **değildir**?

A) İşsizlik oranının fazla olması

B) Gecekondulaşma oranının artması

C) Obez bireylerin sayısının artması

D) Tarım yapılacak alanların yerleşime açılması

E) Enerji ihtiyacının artması

F) Bilmiyorum

12)

Kasabanın 20 yıl önceki hâli

Kasabanın bugünkü hâli

12 yaşındaki Mehmet, içinden nehir geçen kasabasının, yukarıda verilen 20 yıl önceki fotoğrafı ile bugünkü halini karşılaştırınca çok üzülüyor. Mehmet bu bölgede yaşanan problemi çözmek amacıyla afişler hazırlayıp arkadaşlarına ve komşularına dağıtıyor.

Aşağıdakilerden hangisi bu afişlerde yer alan cümlelerden biri **olamaz**?

A) Çöplerimizi çöp kutusuna atalım.

B) Çevremizde ağaçlandırma çalışması başlatalım.

C) Nehir sularını kirletmeyelim.

D) Organik tarım yaparak toprağı koruyalım.

E) Yeşil alanları binalara dönüştürmeyelim.

F) Bilmiyorum.

13) Aşağıdaki atık haline gelmiş ürünlerden hangileri **geri dönüştürülebilir**?

I. Pil

II. Teneke kutu

III. Süt kutusu

IV. Cam kavanoz

A) II, III, IV B) I, II C) II, IV D) I, III, IV E) I, III F) Bilmiyorum

14) Fosil yakıtların kullanımının artması, çevreye zararlı değişimlere neden olur. Aşağıdakilerden hangisi bu sorunu önlemeye yönelik bir uygulama **olamaz**?

A) Toplu taşıma araçları yerine kişisel otomobilleri kullanmak.

B) Fabrikalarda arıtma tesislerini yaygınlaştırmak.

C) Enerji kullanımını azaltmak.

D) Doğal çevreye daha az zarar veren enerji kaynaklarına yönelmek.

E) Ev ve işyerlerine ısı yalıtımı yaptırmak.

F) Bilmiyorum.

15) Ozon tabakası ile ilgili olarak aşağıdaki ifadelerden hangisi ya da hangileri **doğrudur?**

I- Ozon tabakasının delinmesi, doğadaki biyolojik çeşitliliğin azalmasına neden olur.

II- Her sprey ve deodorant ozon tabakasının incelmesine neden olmaz.

III- Hava kirliliğine neden olan bazı maddeler ozon tabakasının kalınlaşmasını sağlar.

A) Yalnız I B) Yalnız II C) I, III D) I, II E) II, III F) Bilmiyorum

16) Aşağıdaki canlılardan hangisinin yaşamının devamını **ışık kirliliği** tehdit etmektedir?

A) Su samuru

B) Akdeniz foku

C) Kelaynak

D) Pers kaplanı

E) Deniz kaplumbağası

F) Bilmiyorum.

17) Aşağıdakilerden hangisi çevreyle ilgili aktif faaliyet gösteren kuruluşlardandır?

I. Kuzey Atlantik Anlaşması Örgütü (NATO)

II. Doğal Hayatı Koruma Vakfı (WWF)

III. Greenpeace

A) I, II, III

B) Yalnız III

C) I, III

D) II, III

E) I, II

F) Bilmiyorum

ENVIRONMENTAL KNOWLEDGE TEST PART 2

ÇEVRE BİLGİSİ TEST BÖLÜM 2

Açıklama: Bu bölümde 16'i çoktan seçmeli, toplam 18 soru yer almaktadır. Bu sorular sizlerin çevre ile ilgili sahip olduğunuz bilgileri ortaya çıkarmak amacıyla hazırlanmıştır. Her sorunun bir doğru cevabı vardır. Yanlışlar doğruları **götürmemektedir**. Anket sonuçları herhangi bir not ile değerlendirilmeyecektir. Sonuçlar sadece araştırmacılar tarafından kullanılacaktır. Yanıtsız bir soru **bırakmamanız**, yapılan araştırma sonuçları için çok önemlidir.

1) Aşağıdakilerden hangisi kömürün yakılmasıyla oluşan **birincil** problemdir?

A) Havaya karbondioksit ve diğer kirleticilerin yayılması.

B) Asit yağmurlarının oluşması.

C) Stratosferdeki ozon miktarının azalması.

D) Yeraltı su havzalarındaki suyun kirlenmesi.

E) Kömür rezervlerinin azalması.

F) Bilmiyorum.

2) Aşağıdakilerden hangisi **yenilenebilir** enerji kaynaklarından **değildir**?

A) Gel-git B) Rüzgâr C) Nükleer D) Jeotermal E) Güneş F) Bilmiyorum

3) Aşağıdaki cümlelerden hangisi geri dönüşümlü ürünler ile ilgili **söylenemez**?

A) Bu ürünlerin kullanımı doğal kaynakların korunmasını sağlar.

B) Çöp olarak bırakılan ürünlerin geri dönüştürülmesi çevre kirliliğini önler.

C) Cam, plastik, kâğıt ve teneke gibi maddeler geri dönüşümlü ürünlerdir.

D) Bu ürünler sanayide tekrar kullanıldıkları için maliyeti artırırlar.

E) Bu ürünlerin kullanımı daha az enerji tüketilmesini sağlar.

F) Bilmiyorum.

4) Bir nehirdeki balıkların sayısında azalma görülüyor ise bu durumun oluşmasında aşağıdakilerden hangisi **en az** etkilidir?

A) Nehire arıtılmamış lağım suları sızmıştır.

B) Nehire fabrika atıkları karışmıştır.

C) Nehire tankerden petrol sızmıştır.

D) Nehire kimyasal gübreler karışmıştır.

E) Nehire çürümüş yiyecekler karışmıştır.

F) Bilmiyorum.

5) Nehirlerin üzerine baraj yapılmasının **en zararlı** etkisi aşağıdakilerden hangisi olabilir?

A) Nehirdeki çamuru arttırması.

B) Yer altı sularının tuzlanması.

C) Su kirliliğinin oluşması.

D) Nehrin doğal ekosistemine zarar vermesi.

E) Nehrin taşmasına neden olması.

F) Bilmiyorum.

6) Aşağıdakilerden hangisi erozyonu önlemek için alınan tedbirlerden **biridir**?

A) Tarlaların eğime paralel sürülmesi.

B) Mera ve otlakların fazla kullanılması.

C) Bataklıkların kurutulması.

D) Fazla sulama yapılması.

E) Rüzgârın hızını kesecek setler oluşturulması.

F) Bilmiyorum.

7) Kömür ve petrol hangi enerji türüne **örnektir**?

A) Yenilenebilir enerji kaynaklarına.

B) Fosil yakıtlara.

C) Alternatif enerji kaynaklarına.

D) Geri dönüştürülmüş kaynaklara.

E) Çevre dostu yakıtlara.

F) Bilmiyorum.

8) Aşağıdakilerden hangisinin artışı küresel ısınmayı **en az** arttırır?

A) Isınmada kömür kullanımı.

B) Orman yangınları.

C) Sigara kullanımı.

D) Petrol kullanımı.

E) Egzoz gazları.

F) Bilmiyorum.

9) 2013 yılı sonunda aşağıdakilerden hangisi Dünya'daki **toplam insan nüfusunun** yaklaşık değeridir?

A) 7,2 milyar.

B) 6,7 milyar.

C) 5,5 milyar.

D) 4,7 milyar.

E) 3,9 milyar.

F) Bilmiyorum.

10) Ozon, atmosferin üst katmanlarında koruyucu bir tabaka oluşturur. Bu tabaka bizi aşağıdaki zararlı oluşumların hangisinden **korur**?

A) Asit yağmurlarından.

B) Küresel ısınmadan.

C) Sıcaklıkta oluşan ani değişimlerden.

D) Kansere neden olan zararlı güneş ışığından.

E) Sera etkisinden.

F) Bilmiyorum.

11) Sera gazları **hangi özelliği** ile küresel ısınmaya neden olmaktadır?

A) Sera gazlarının zehirleyici olmaları.

B) Atmosferin daha yüksek katmanlarında yer almaları.

C) Diğer gazlarla reaksiyona girmeleri.

D) Gaz olmaları.

E) Yeryüzünden yansıyan güneş ışınlarını tutmaları.

F) Bilmiyorum.

12) Dünyanın sıcaklığında gerçekleşen artışın, aşağıdakilerden hangisine yol açması **beklenmez**?

A) İklim değişimine.

B) Kutuplarda buzulların erimesine.

C) Ozon tabakasının incelmesine.

D) Kuraklıkların artışına.

E) Bazı bitki/hayvan türlerinin tükenmesine.

F) Bilmiyorum.

13) Organik tarımla ilgili olarak aşağıdakilerden hangisi **yanlıştır**?

A) Temel amaçlarından biri ürün kalitesini arttırmaktır.

B) Doğa dostu bir tarım yöntemidir.

C) Üretilen ürünler özel etiket ve organik tarım logosu ile satışa sunulur.

D) Toprağın, su kaynaklarının ve havanın korunmasını sağlayan bir üretim yapılır.

E) Üretimi arttırmak amacıyla bazen kimyasal gübreler kullanılabilir.

F) Bilmiyorum.

14) Sevgi Hanım, bir ürünü satın almadan önce o ürüne gerçekten ihtiyacı olup olmadığını düşünür. Aldığı ürünlerin kutularını ise atmayarak kalem kutusu gibi farklı amaçlar için kullanır. Kullandığı kâğıt ve şişeleri ise onlar için ayrılmış kutulara koyarak ayrı toplanmasını sağlar.

Sevgi Hanım'ın bu davranışı, aşağıda verilen çevre konularından **öncelikle** hangisiyle ilişkilendirilebilir?

A) Toprak kirliliği.

B) Atıkların geri kazanımı.

C) Hava kirliliği.

D) Su kirliliği.

E) Küresel ısınma.

F) Bilmiyorum.

15) Aşağıdakilerden hangisi toprağın korunduğuna veya verimli kullanıldığına bir **örnektir**?

A) Sanayi tesislerinin tarım alanlarına yayılması.

B) Bitki ve havyan atıklarından oluşan gübrelerin toprağa karıştırılması.

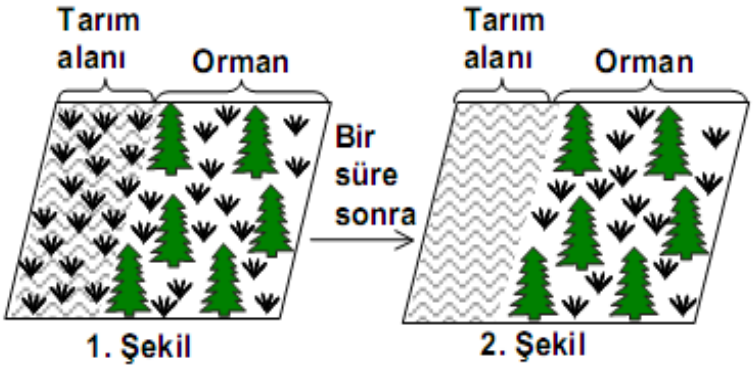
C) Kıyılardaki meyve bahçelerine turistik tesislerin kurulması.

D) Tarım alanlarının baraj suları altında kalması.

E) Topraktan daha fazla ürün almak için kimyasal ilaçların kullanılması.

F) Bilmiyorum.

16)



Yabani ot simgesi ile gösterilmiştir.

Bir bölgede yabani ot, 1. şekildeki gibi yayılma göstermiştir. Çiftçiler, yabani otla mücadele için bu bölgede yabani otla beslenen böcek türünü çoğaltmışlardır. Bir süre sonra bölgede 2. şekildeki durum gözlendiğine göre aşağıdakilerden hangisi **söylenemez**?

A) Bölgenin iklim koşulları, yabani otun yayılmasını engellemiştir.

B) Böcek tarım alanı olan bölgede, yabani otun yayılmasını engellemiştir.

C) Böceğin ormanda yaşamasını engelleyen koşullar vardır.

D) Yabani ot, böceğin yaşadığı alandan daha geniş alanlara yayılmıştır.

E) Tarım alanındaki mücadele ormandakine göre daha etkili olmuştur.

F) Bilmiyorum.

17) Aşağıdaki sembollerin anlamlarını açıklayan **numaraları**, sembollerin altındaki boşluklara **yerleştiriniz**.


.....


.....


.....


.....

Numara	Açıklamalar
1	Geri dönüştürülmüş ürünlerden yapılmış.
2	Çevre için tehlikeli.
3	Ambalajların geri kazanımı ile ilgili görevlerini yerine getiren firmalara verilen simge.
4	Zehirli madde.
5	Geri dönüştürülebilir veya geri kazanılabilir.
6	Yüksek derecece yanabilir.

18) Aşağıda piller ile ilgili bazı bilgiler verilmiştir. Sizce bu bilgilerin hangileri doğru, hangileri yanlıştır?

Doğru için “D”
Yanlış için “Y”
Bilmiyor iseniz “B” kullanınız.

……Piller doğrudan toprağa gömülerek çevreye zararsız hale getirilir.
……Piller içerdikleri kimyasal maddeler nedeniyle tehlikelidir.
……Atık piller, diğer çöplerden ayrı toplanır.
……Akmış pillere elle dokunulması sağlık açısından zararlıdır.

APPENDIX D: CHILDREN'S RESPONSIBLE ENVIRONMENTAL BEHAVIOR SCALE (CREBS)

ÇEVREYE YÖNELİK SORUMLU DAVRANIŞ ÖLÇEĞİ

Bu bölüm sizlerin çevreyi korumak ve çevre problemlerini çözmek için yapmış olduğunuz eylemlerin belirlenmesi için hazırlanmıştır. Bu bölümde çevrenin korunması ile ilgili birbirinden farklı bazı davranışlar verilmektedir. Her bir davranışı dikkatlice okuyunuz ve bu davranışları son bir yıl içerisinde hangi sıklıkla yaptığınızı yan taraftaki uygun seçeneklerden **bir tanesini** X işareti koyarak belirtiniz		**Son bir yıl içinde kaç kere yaptın?**						
		Hiç	**Bir kere**	**2 kere**	**3 kere**	**4 kere**	**5 kere**	**5'ten fazla**
1	Çevre korumanın önemi ve çevre koruma ile ilgili konularda, devlet yetkilileri (örn. Başbakan, Çevre ve Orman Bakanı ve Vali) ile iletişim kurmak için planlar yaptım. (örn. mektup hazırlamak, e-mail hazırlamak)							
2	Çevre koruma önlemleri almaları için belediye başkanını ziyaret ettim ve bu konuda onu teşvik ettim.							
3	Çevre koruma önlemleri almaları için mahalle muhtarını ziyaret ettim ve bu konuda onu teşvik ettim.							
4	Kurallara ve yasalara uymayarak çevreye zarar veren kişilere ceza vermesi için yerel devlet yetkilileri ile konuştum.							
5	Halkın çevre duyarlılığını ve çevreyi korumaya yönelik desteğini arttırmak için, çevre ile ilgili gazete, dergi ve sokak panoları hazırlamaları konusunda devlet yetkililerini teşvik ettim.							
6	Devlet yetkilileri ve sivil toplum kuruluşlarının temsilcileri ile çevre koruma projeleri hazırlamak ve bu projeleri uygulamak için ortak çalıştım.							
7	Okuldayken, evdeyken, piknikteyken, parktayken ve sokaktayken çöplerimi uygun bir şekilde çöp tenekesine attım.							
8	Okulda, piknikte, parkta ve sokakta yerlere atılan çöpleri toplayıp çöp tenekesine attım.							
9	Kullanılmış kağıt, cam, plastik, alüminyum kutu ve pil gibi atıkları geri dönüşüm kutusuna attım.							
10	Bitkileri korumak için önlemler aldım (örn. kurumaması için ağaç ve çiçekleri suladım, bitkilere zarar veren ve ezenleri uyardım).							
11	Sokaklarda yaşayan kedi, köpek ve kuş gibi hayvanları korumak için önlemler aldım (örn. Onlara yuva yaptım, onlara yiyecek verdim, onları zararlardan korudum).							
12	Su tasarrufu yapmak için önlemler aldım (örn. Kullanılmayan çeşmeleri kapattım, banyo yaparken, el yıkarken ve diş fırçalarken aşırı su kullanmadım).							

Bu bölüm sizlerin çevreyi korumak ve çevre problemlerini çözmek için yapmış olduğunuz eylemlerin belirlenmesi için hazırlanmıştır. Bu bölümde çevrenin korunması ile ilgili birbirinden farklı bazı davranışlar verilmektedir. Her bir davranışı dikkatlice okuyunuz ve bu davranışları son bir yıl içerisinde hangi sıklıkla yaptığınızı yan taraftaki uygun seçeneklerden **bir tanesini** X işareti koyarak belirtiniz.		**Son bir yıl içinde kaç kere yaptın?**						
		Hiç	**Bir kere**	**2 kere**	**3 kere**	**4 kere**	**5 kere**	**5'ten**
13	Geri dönüştürülebilen veya geri dönüştürülmüş maddelerden yapılmış ürünler satın aldım (örn. Üzerinde geri dönüşüm işareti olan ürünlerden satın aldım)							
14	Türk Standartları Enstitüsü (TSE) ve Tarım ve Köy İşleri Bakanlığı tarafından onaylanan ve test edilen ürünlerden satın aldım.							
15	Taze, sağlıklı, son kullanma tarihi geçmemiş ve organik/ekolojik ürünler satın aldım.							
16	Su ve elektriği gereksiz yere kullanmamaları için ailemi, arkadaşlarımı ve diğer insanları uyardım.							
17	Eski ve kullanmadığım kitap, giysi, oyuncak ve diğer eşyaları gereksinimi olan kişi ve kuruluşlara verdim.							
18	Çevrenin korunması ve çevreye zarar vermemek için ne yapacakları konusunda **ailem** ile konuştum.							
19	Çevrenin korunması ve çevreye zarar vermemek için ne yapacakları konusunda **arkadaşlarım** ile konuştum.							
20	Çevrenin korunması ve çevreye zarar vermemek için ne yapacakları konusunda **diğer insanlar** ile konuştum.							
21	Çevrenin güzelleşmesi için ağaç, çiçek, sebze ve diğer tür bitkilerden diktim ve yetiştirdim.							
22	Çevrenin korunması ve güzelleşmesi için çalışan ulusal ve yerel sivil toplum kuruluşlarına (örn. TEMA) yardımda bulundum.							
23	Okuldaki panolara asmak için çevrenin korunması ile ilgili poster, resim ve yazılar hazırladım.							

APPENDIX E: THE AFFECTIVE DISPOSITION TOWARD ENVIRONMENT SCALE (ADTES)

ÇEVREYE YÖNELİK DUYUŞSAL EĞİLİMLER ÖLÇEĞİ

Aşağıda sizlerin çevreye yönelik duygu ve düşünceleriniz ile ilgili 14 farklı cümle yer almaktadır. Lütfen her bir cümleyi dikkatlice okuyup size en uygun olan kutucuğun içine (x) işareti koyunuz. Sonuçlar herhangi bir not ile değerlendirilmeyecektir ve sadece araştırmacı tarafından kullanılacaktır. **Tüm soruları yanıtlamanız** yapılan araştırma sonuçları için çok önemlidir.

Lütfen her bir cümleyi dikkatlice okuyup size en uygun olan kutucuğun içine (x) işareti koyunuz.	**Kesinlikle katılmıyorum** **A seçeneği**	**Katılmıyorum** **B seçeneği**	**Katılıyorum** **C seçeneği**	**Kesinlikle katılıyorum** **D seçeneği**
1. İnsanlar çevreye önem vermelidir.				
2. Kendimi çevreye yönelik olumlu duygular besleyen birisi olarak görüyorum.				
3. Sık sık çevre ve doğa ile ilgili yazılar (kitap, dergi vb.) okurum.				
4. Televizyonda ne zaman bir doğa ve çevre ile ilgili bir program olsa izlerim.				
5. Doğal kaynakların dikkatli kullanılması önemlidir.				
6. Toprak kaymasını ve erozyonu önlemek için ağaç dikimi teşvik edilmelidir (desteklenmelidir).				
7. Yırtıcı ve vahşi hayvanlar öldürülmemelidir, çünkü onların da yaşama hakkı vardır.				
8. Çevre problemlerinin çözümü için bu konuda çalışan insanlara yardım ederim.				
9. Canlıların doğal yaşam alanlarının korunmasına yönelik benim de yapacak olduğum bir şeyler olduğunu düşünüyorum.				
10. Çevre kirliliğinin önlenmesinde, kişisel sorumluluk çok önemlidir.				
11. Doğal kaynakları korumak için, yaşam tarzımda değişiklik yapabilirim.				
12. Çevre sorunlarını önlemek için tedbirler (geri dönüşümlü ürünleri kullanmak vb.) almak isterim.				
13. Çevreyi korumaları için insanları bir şeyler yapmaları konusunda teşvik etmek isterim.				
14. Çevrenin korunması için devlet yetkilileri ile konuşmak isterim.				

APPENDIX F: PROBLEM IDENTIFICATION AND PROBLEM-SOLVING SKILLS TEST TOWARDS ENVIRONMENT (PIPSSTE)

PROBLEM BELİRLEME VE PROBLEM ÇÖZME BECERİLERİ TESTİ

Bu bölüm, sizin çevre sorunları ile ilgili ne düşündüğünüzü ve bu sorunların çözümüne yönelik nasıl davrandığınızı belirlemek amacıyla hazırlanmıştır. Aşağıda göl kirliliği ve çöpler hakkında iki ayrı metin verilmiştir. Metinleri ve bu metinlerle ilgili yönergeleri dikkatlice okuyunuz ve ilgili soruları cevaplayınız.

BÖLÜM 1: GÖL NEDEN KİRLİ?

O günkü Fen ve Teknoloji dersinde, öğretmen su kaynaklarının canlılar için önemini açıkladı. Örnek olarak okullarının yakınlarında bulunan gölü verdi. Son zamanlarda bu gölün içinde yaşayan balıkların ölü olarak su yüzüne çıktıklarını anlattı. Ders bitiminde öğretmen performans görevi olarak öğrencilerden, bu göldeki balıkların neden ölmüş olabileceğine dair 2 ay sürecek bir araştırmayı planlamalarını ve uygulamalarını; elde ettikleri sonuçları sınıftaki arkadaşlarıyla paylaşmalarını istedi.

YÖNERGE:

Bu sınıftaki öğrencilerden biri olsaydınız bu konuyu araştırmak için aşağıdaki işlemleri hangi sırayla yapar ve uygulardınız?

İşlemler

A. Deney yapmak için gölden su örnekleri alırım.

B. Bu çevre sorununu daha iyi tanımlamak için göldeki balıkların yaşam koşulları hakkında ilgili kitaplardan ve internetten bilgi toplarım.

C. Gölün bulunduğu alana gider, göl çevresinde gözlemler yaparım ve gözlemleri kaydederim.

D. Deneylerden elde ettiğim tüm sonuçları ve değerlendirmelerimi defterime kaydederim.

E. Elde etmiş olduğum tüm verileri rapor haline getirerek sınıfta sunarım.

F. Farklı günlerde ve saatlerde aldığım su örneklerine ait deney sonuçlarını karşılaştırırım.

G. Sonuçları yorumlarım.

H. Su örneklerini incelemek için deney düzeneğini hazırlarım ve deneyleri gerçekleştiririm.

Yukarıdaki işlemlerin hangi sırada yapılması gerektiğini aşağıdaki sayıların yanına işlemi belirten harfini (A, B, …, H vb.) yazarak belirtiniz.
1)…… 2) ……..… 3) ……..… 4) ……. 5) ….…… 6) ……..… 7) ….…… 8) ….……

GÖLÜN KİRLENMESİNİ NASIL ÖNLEYEBİLİRSİNİZ?

Araştırmanız sonucunda göldeki balıkların, **kirlilik nedeniyle öldüğünü** tespit ettiniz. Buna göre; aşağıdaki soruları cevaplayınız.

1) Göl **hangi nedenlerle kirlenmiş** olabilir? Birden fazla kirlilik nedeni yazabilirsiniz.

……

……

……

……

2) "1" nolu soruda belirlediğiniz nedenlerden **birini** seçiniz:…….

Gölün sizin seçtiğiniz **bu nedenle** kirlendiğini ortaya koymak isteseydiniz nasıl bir yöntem izlerdiniz? Yapacağınız işlemleri adım adım sırasıyla yazınız.

……

……

……

……

……

……

……

……

3) Yukarıda belirlediğiniz kirlilik nedenini ortadan kaldırmak veya azaltmak için neler yapardınız? Birden fazla öneri yazabilirsiniz.

……

……

……

……

BÖLÜM 2: KASABADAKİ ÇÖPLER

Ayşe, yaşamakta olduğu kasabanın çöplerinin, kasabanın hemen dışında açık bir alana atıldığını ve atılan çöp miktarının oldukça fazla olduğunu gözlemledi. Çöplerin arasında plastik, kâğıt gibi atık haline gelmiş ürünlerin yanı sıra farklı atıklar (tıbbi atıklar, yemek atıkları vb.) da vardı.

Ayşe, çöplerin çevreye ve doğaya verdiği zararlar ile çöpler hakkında kasabadaki kişilerin görüşlerini öğrenmek amacıyla bir araştırma yapmaya karar verdi.

YÖNERGE:

Sizce Ayşe bu konuyu araştırmak için aşağıdaki işlemleri hangi sırayla yapmalıdır?

İşlemler

A. Farklı çöp atma alışkanlıklarındaki kişilerin bir hafta boyunca attıkları çöplerinin ağırlıklarını tartar, hacimlerini hesaplar ve kayıt eder.

B. Çalışmalarından sonuçlar çıkarır, elde ettiği verileri yorumlar.

C. Kasabadaki kişilerin, çöpler ile ilgili görüşlerini ve çöplerini atma konusundaki alışkanlıklarını öğrenmek amacıyla bir anket hazırlar ve uygular.

D. Çöplerin zararları hakkında ilgili kitaplardan ve internetten bilgi toplar; insanların çöplerle ilgili görüşleri konu edinen araştırmaları inceler.

E. Farklı çöp atma alışkanlıklarındaki kişilerin bir hafta boyunca attıkları çöplerin çeşitliliğini (plastik, kağıt vb.) gözlemler, gözlem sonuçlarını kaydeder ve karşılaştırır.

F. Elde etmiş olduğu tüm verileri rapor haline getirerek kasabada yaşayan kişilere sunar.

G. Farklı çöp atma alışkanlıklarındaki ve çöpleri sorun olarak görmeyen kişilerden kendileriyle ilgili topladığı tüm verilere dayanarak küçük bir grup oluşturur, çöplerin bir çevre sorunu olarak görülmemesinin nedenlerini öğrenmek amacıyla görüşmeler yapar.

Yukarıdaki işlemlerin hangi sırada yapılması gerektiğini aşağıdaki sayıların yanına işlemi belirten harfini (A, B, …, H vb.) yazarak belirtiniz.
1) …… 2) …… 3) …… 4) …… 5) …… 6) …… 7) ……

KASABADAKİ ÇÖPLERİN YARATTIĞI PROBLEMLERİ NASIL AZALTABİLİRSİNİZ?

Ayşe yaşamakta olduğu kasabanın çöplerinin kasabanın hemen dışında açık bir alana atıldığını ve atılan çöp miktarının oldukça fazla olduğunu gözlemlemişti. Çöplerin arasında plastik, kâğıt gibi atık haline gelmiş ürünlerin yanı sıra farklı atıkların (tıbbi atıklar, yemek atıkları vb.) da olduğunu fark etmişti.

Ayşe yaptığı araştırma **sonucunda** kasabada yaşayan kişilerin çöpleri bir çevre sorunu olarak gördüklerini öğrendi ve onların çöp atma alışkanlıkları hakkında da bilgilere ulaştı.

1) Çöpler, çevrede/doğada **ne tür sorunlar** yaratıyor olabilir? Birden fazla sorun yazabilirsiniz.

……

……

……

……

2) "1" nolu soruda belirlediğiniz sorunlardan **birini** seçiniz:……..

Kasabanın, kasabanın çevresinin/doğasının **bu sorundan** etkilendiğini ortaya koymak isteseydiniz nasıl bir yöntem izlerdiniz? Yapacağınız işlemleri adım adım sırasıyla yazınız.

……

……

……

……

……

3) Yukarıda belirlediğiniz sorunu ortadan kaldırmak veya azaltmak için neler yapardınız? Birden fazla öneri yazabilirsiniz.

……

APPENDIX G: ATTITUDE SCALE TOWARDS RECOVERY OF PACKAGING WASTES

AMBALAJ ATIKLARININ GERİ KAZANIMINA YÖNELİK TUTUM ÖLÇEĞİ

Sevgili Öğrenciler,

Bu ölçek sizin ambalaj atıklarının geri kazanımına yönelik tutumlarınızı belirlemek amacıyla geliştirilmiştir. Burada belirteceğiniz görüşler yalnızca araştırma amacıyla kullanılacak ve sonuçlar tüm grubun yanıtları göz önüne alınarak değerlendirilecektir. Gerçek düşüncelerinizi belirtmeniz özel bir önem taşımaktadır. Lütfen **hiçbir maddeyi boş bırakmayınız** ve her bir madde için **tek yanıt** veriniz. Bilimsel bir çalışmaya yaptığınız katkılardan dolayı teşekkür ederim.

Maddeleri yanıtlarken sizden şöyle bir yol izlemeniz istenmektedir:

1. Lütfen her bir maddeyi dikkatlice okuyunuz.

2. Okuduğunuz maddenin sizin için ne kadar uygun olduğunu (ya da olmadığını) kararlaştırınız.

3. Yanıt vermek için şu seçeneklerden birini işaretleyiniz:

Kesinlikle katılıyorum Katılıyorum Kararsızım Katılmıyorum Kesinlikle katılmıyorum

MADDE NO	AMBALAJ ATIKLARININ GERİ KAZANIMA YÖNELİK TUTUM ÖLÇEĞİ	Kesinlikle katılıyorum (%100) A seçeneği	Katılıyorum (%50 den fazla) B seçeneği	Kararsızım (%50) C seçeneği	Katılmıyorum (% 50 den az) D seçeneği	Kesinlikle katılmıyorum (%0) E seçeneği
1	Tek kullanımlık PET şişeler yerine, tekrar doldurulabilir plastik su şişelerinin veya termosların kullanılması teşvik edilmelidir.					
2	Cam, plastik gibi ambalaj atıkları doğada bir süre sonra kendiliğinden yok olur. Bu nedenle bunların geri dönüşümü için çaba harcamak gereksizdir.					
3	Doğaya çok miktarda atık bırakan firmalardan daha çok vergi alınmalıdır.					
4	Televizyonlarda; denizlerin, akarsuların ve göllerin atıklarla kirletildiği hakkında verilen haberler abartılıdır.					
5	Çalışmalarımda kullandığım kâğıtların tek yüzü yerine her iki yüzünü de kullanmaya özen gösteririm.					

MADDE NO	AMBALAJ ATIKLARININ GERİ KAZANIMA YÖNELİK TUTUM ÖLÇEĞİ	Kesinlikle katılıyorum (%100) A seçeneği	Katılıyorum (%50 den fazla) B seçeneği	Kararsızım (%50) C seçeneği	Katılmıyorum (% 50 den az) D seçeneği	Kesinlikle katılmıyorum (%0) E seçeneği
6	Kâğıt, metal, plastik vb. ambalaj atıklarının çöplerden ayrı toplanması kişilerin isteğine bırakılmalıdır.					
7	Evlerde, işyerlerinde, okullarda ambalaj atıklarının çöplerden ayrı toplanması uygulanabilir bir fikir değildir.					
8	Ambalaj atıklarını geri kazandırırsam yaşadığım şehrin çöp depolama alanlarının daha uzun süre kullanılmasına bir katkım olabilir.					
9	Geri dönüşümün verimli hale getirilmesinden sadece belediyeler sorumludur.					
10	Teneke kutu ve diğer içecek kutularının geri dönüştürülmek üzere toplanması caddelerimizdeki kirliliği azaltır.					
11	Atıkların geri kazandırılması yeni iş alanlarının oluşmasına yardımcı olur.					

MADDE NO	AMBALAJ ATIKLARININ GERİ KAZANIMA YÖNELİK TUTUM ÖLÇEĞİ	Kesinlikle katılıyorum (%100) A seçeneği	Katılıyorum (%50 den fazla) B seçeneği	Kararsızım (%50) C seçeneği	Katılmıyorum (% 50 den az) D seçeneği	Kesinlikle katılmıyorum (%0) E seçeneği
12	Ambalaj atıklarının geri kazanımını arttırmak için gerekirse yaşam tarzımı değiştiririm.					
13	İnsanlara geri dönüşümün yararlarını anlatmak için gereken desteği vermeye hazırım.					
14	Ambalaj atıklarının geri kazanımı konusunda düzenlenecek bir seminere katılmak isterim.					
15	Geri kazanım ve geri dönüşüm çabalarının yetersiz kalmasının temel nedeni insanların duyarsızlığıdır.					

APPENDIX H: PACKAGING WASTE RECOVERY ACHIEVEMENT TEST (PWRAT)

AMBALAJ ATIKLARININ GERİ KAZANIMI BAŞARI TESTİ

Değerli Öğrenciler,

Bu testte yer alan sorular, ambalaj atıklarının geri kazanımı ile ilgili bilgi düzeyinizi belirlemek amacıyla hazırlanmıştır. Bu testin sonuçları herhangi **bir not ile değerlendirilmeyecektir**. Sonuçlar sadece araştırmacı tarafından kullanılacaktır. Yanıtsız bir soru **bırakmamanız**, yapılan araştırma sonuçları için çok önemlidir. Katılımınız için teşekkür ederiz.

1) Aşağıdakilerden hangisi **"yeniden kullanım"** kavramını tanımlar?

A) Atık maddelerin fiziksel ve kimyasal işlemlerden geçirildikten sonra tekrar kullanılabilir hale getirilmesidir.
B) Atık maddelerden yakılarak enerji elde edilmesidir.
C) Atıkların toplama ve temizleme dışında hiçbir işleme tabi tutulmadan aynı şekli ile defalarca kullanılmasıdır.
D) Atık materyallerin hiçbir işlem yapılmadan belli bir süre bekletildikten sonra tekrar kullanılmasıdır.
E) Atık materyallerin kompostlaştırılarak gübre haline getirilmesi ve tekrar kullanılmasıdır.
F) Bilmiyorum.

2) Aşağıdaki uygulamalardan hangisi **geri kazanım** kapsamı içinde **değerlendirilmez**?

A) Damacanaların tekrar doldurulmak üzere su firmasına geri verilmesi.
B) Alüminyum kutuların toplanıp tekrar alüminyum üretiminde kullanılması.
C) Atık kağıtların boş olan arka yüzlerinin de kullanılması.
D) Kullanılıp atılan ürünlerin tercih edilmesi.
E) Atık maddelerin yakılarak enerji elde edilmesi.
F) Bilmiyorum.

3) Geri kazanım konusunda uygulamalarda bulunmak isteyen bir kişi, aşağıdaki faaliyetlerinden hangisi ya da hangilerini gerçekleştirerek bu yönde çalışmış olur?

I. Cam kavanozların cam üretiminde tekrar kullanılması için geri dönüşüm kutularına atar.

II. Reçel kavanozlarını yıkayıp tekrar reçel koyar.

III. Satın alınan ürünlerin ambalajlarını çöplerden ayrı bir yerde biriktirir.

A) Yalnız I
B) Yalnız II
C) I, III
D) II, III
E) I, II, III
F) Bilmiyorum

4) "**Geri kazanım**" kavramını açıklayınız.

……..……..……

……..……..……

5) Kullanılmış süt ve meyve suyu kutuları, cam veya plastik şişeler, teneke ve metal konserve kutuları ambalaj atıklarına örnektir. Ambalaj atıklarının geri dönüştürülmesi sürecinde gerçekleştirilen "**geri dönüşüm ve ikincil ürünlere dönüştürme**", "**toplama**", "**sınıflama**" ve "**ayırma**" basamaklarını **<u>doğru</u>** sırada yazarak belirtiniz.

……..……..……

……..……..……

6) Ambalaj atıklarının geri dönüştürülmesi sürecinde gerçekleştirilen "**geri dönüşüm ve ikincil ürünlere dönüştürme**", "**toplama**", "**sınıflama**" ve "**ayırma**" basamaklarını açıklayınız.

Geri dönüşüm ve ikincil ürünlere dönüştürme:……

……

Sınıflama: ……

……

Toplama:……

……

Ayırma:……

……

7) Aşağıdaki sembollerin anlamlarını yanlarında belirtilen boşluklara yazınız.

……

……

……

……

8) Ambalaj atıklarının geri kazanımının **<u>çevreye</u>**, **<u>ekonomiye</u>** ve **<u>topluma</u>** sağlayacağı yararlar var mıdır? **<u>Nedenleriyle</u>** yazınız.

……

……

……

9) Aşağıdaki atık haline gelmiş kağıt ürünlerden geri dönüştürülebilenlere (√) işareti, geri dönüştürülemeyenlere (x) işareti koyunuz.

(....) Gazete (....) Faks kağıtları (....) Dergi
(....) Besin bulaşmış kağıtlar (....) Kese kağıtları (....) Islanmış kağıtlar
(....) Karton (....) Yağlı kağıtlar

10) Kağıt/karton ambalaj atıklarının geri dönüşümü sonucunda elde edilen ürünlerden **iki** tanesini yazınız.

……

11) Aşağıdaki atık haline gelmiş cam ürünlerden geri dönüştürülebilenlere (√) işareti, geri dönüştürülemeyenlere (x) işareti koyunuz.

(....) Cam su şişesi (....) Ampül (....) Cam kase
(....) Ayna (....) Pencere camı (....) Parfüm şişeleri

12) Aşağıdaki atık haline gelmiş plastik ürünlerin geri dönüşümünden elde edilenlere (√) işareti, plastik ürünlerin geri dönüşümünden elde edilemeyenlere (X) işareti koyunuz.

(....) Uyku tulumu (....) Su borusu (....) Tişört
(....) İnşaat dolgu malzemeleri (....) Araba lastiği (....) Yer döşemesi
(....) Plastik mutfak malzemeleri (….) İplik

13) Süt ve meyve suyu gibi içeceklerin kutuları kompozit ambalaj atıklarıdır. Bunların geri dönüştürülmesi sonucunda elde edilen ürünlerden **birini** yazınız.

……

APPENDIX I: SAMPLE LESSON PLAN

ETKİNLİK 2: KATI ATIKLARI SINIFLANDIRIYORUM

Kazanım(lar) :

- Farklı yerlerde gözlemlediği katı atıkları sınıflar.
- Farklı yerlerde gözlemlediği katı atıklarla ilgili sonuç çıkarır.
- Günlük yaklaşık kaç kg katı atık attığını tahmin eder.
- F.7.4.5.4. Yakın çevresinde atık kontrolüne özen gösterir.

Materyal : Farklı türlerde otuz katı atık, kalem, atık kağıt, "Ek 1: Katı Atıklarımı Sınıflandırıyorum", "Ek 2: Bilgilendirme Metni", "Ek 3: Değerlendirme için Çıkış Kartı", "Ek 4: Günlük Kaç Kg Katı Atık Atıyorum?"

Anahtar kelime : Çöp, atık, katı atık, atık türleri, gözlem

Süre : 90 dk.

Ön Hazırlık :

- Öğretmen çalışma mekanına farklı katı atık örnekleri seçerek getirir ve masaların üzerine yerleştirir.
- "Ek 2: Bilgilendirme Metni", öğrenci sayısının yarısı kadar (arkalı-önlü) çoğaltılır.

Ön Bilgi :

Üretimden tüketime kadar olan tüm aşamalarda ortaya çıkan, kullanıcının artık işine yaramayan ve yaşadığımız ortamdan uzaklaştırılması gereken katı maddelere "**katı atık**" denir. Katı atık halk dilinde "çöp" olarak bilinir. Katı atıklar evde, okulda, iş yerlerinde, hastanelerde, endüstride, park ve bahçelerde vb. birçok yerde oluşabilir. Atıklar, çevre ve insan sağlığına etkileri açısından tehlikeli ve tehlikesiz olarak değerlendirilmektedir. Tehlikeli atıklar, içerdikleri zararlı kimyasallar ve diğer maddeler nedeniyle insan ve çevre sağlığı açısından kalıcı etkiler, zararlar verebilirler. Bu nedenle tehlikesiz atıklardan da farklı özel yöntemlerle toplanmaları, taşınmaları, geri kazanılmaları veya bertaraf edilmeleri gerekmektedir. Konutlardan atılan, tehlikeli ve zararlı atık kavramına girmeyen,

bahçe, park ve piknik alanları gibi yerlerden gelen katı atıklara "**evsel katı atık**" denir[1]. Katı atıklar farklı şekillerde sınıflandırılabilinir. Kentsel atıklar kendi içinde farklılık göstermektedir.

Evsel atıklar

Evsel atıklar, evlerden ve iş yerlerinden çıkan, park, bahçe gibi alanlardan gelen, tehlikeli olmayan, belediye hizmeti ile toplanıp taşınan çöp depolama sahalarında bertaraf edilebilen, ayırma yolu ile gerikazanılabilen, kompost yapılabilen veya termal yöntemlerle işlenebilen evsel veya endüstri kökenli atıklardır. Evsel atıkların miktar ve özellikleri, yaşanılan yerin sosyo-ekonomik seviyesine, beslenme alışkanlığına, kullanılan yakıt cinsine vb. faktörlere bağlı olarak değişmektedir. Evsel atık içerisinde bulunan yiyecek atıkları organik yapıda olduklarından kolayca ayrışabilir. Evsel atıklarda bulunan değerlendirilebilir kuru atıklar- cam ve seramik, kâğıt/karton, plastik (PET, PVC, PP, PS, PE), kauçuk, metal (alüminyum, demir, pirinç alaşımları, bakır), tekstil, deri, ahşap vb.dir. Yaş atıklar kompostlaştırma yöntemiyle değerlendirilebilmektedir. Bitkisel ve hayvansal atıkların nemli-oksijenli ortamda bozunarak organik gübreye dönüşmesi olayına "kompostlaşma" denir. Evlerimizde oluşan katı atıklara "evsel katı atıklar" denir. İki tür evsel atık vardır: Organik atıklar ve ambalaj atıkları

Endüstriyel atıklar

Endüstriyel faaliyetlerden kaynaklanan atıklara "endüstriyel atık" denir. Fabrikalarda üretim sırasında ortaya çıkan katı, sıvı ve gaz atıkları örnek olarak verilebilir.

Tehlikeli atıklar

Katı Atıkların Kontrolü Yönetmeliği- zararlı ve tehlikeli atığı, patlayıcı, parlayıcı, kendiliğinden yanmaya müsait, suyla temas halinde patlayıcı gazlar çıkaran, oksitleyici organik peroksit içerikli, zehirli korozif (aşındırıcı), hava ve suyla temasında toksik gaz bırakan Bakanlıkça tehlikeli ve zararlı atık olduğu onaylanan atıklar olarak tanımlamıştır. Tehlikeli atıklar çoğunlukla sanayi kuruluşları, araştırma merkezleri, hastaneler, kısmen konutlar vb. yerlerden kaynaklanmaktadır. Evlerden gelen basınçlı kaplar, sanayi atıkları içerisindeki birçok kimyasallar, hastanelerden kaynaklanan radyoaktif atıklar tehlikeli atık sınıfına girerler.

Tıbbi atıklar

Sağlık kuruluşları, araştırma kuruluşları ve laboratuarlar tarafından oluşturulan tüm atıklar tıbbi atıktır. Bunun dışında evde yapılan tıbbi bakım (diyaliz, insülin enjeksiyonları) esnasında üretilen

[2] T.C. Çevre Bakanlığı (1991). Katı Atıkların Kontrolü Yönetmeliği. T.C. Resmi Gazete No:20814, Tarih: 14.03.1991.

atıklar gibi küçük veya dağınık durumda bulunan kaynaklardan çıkan atıklar da tıbbi atıktır.

Elektronik atıklar

Kullanım ömrünü tamamlamış olan, içerisinde bir veya daha fazla elektrik iletim elemanı bulunduran ürünlere "elektronik atık" adı verilir. Bozuk, kırık, tamir edilemez olarak görülen veri işleme, telekomünikasyon, iş eğlence veya ev için kullanılan araç gereçler genel olarak bu gruba dahil edilmektedir.

Uygulama :

Uygulama 1 (20 dk.)

Açıklama: Bu uygulama ile öğrencilerin oyun oynayarak çevrelerinde gördükleri farklı katı türlerini söyleyebilmeleri amaçlanmaktadır.

- Çalışma mekanına getirilen farklı atıklar mekanın değişik yerlerine görülebilir olacak şekilde yerleştirilir.
- (5 dk.) Öğrencilere oynayacaklarını oyunun amacı ve kuralları kısaca açıklanır. Oyunda, kendilerine verilen 2 dakika içerisinde mekanda dolaşmaları ve atıklara ellemeden mümkün olduğu kadar fazla sayıda katı atığı görmeleri ve bunları hatırlamaları amaçlanmaktadır. Herkesin bireysel ve sessiz çalışması gerekmektedir.
- (2 dk.) Oynamaları için öğrencilere süre verilir.
- (8 dk.) 2 dakika sonunda atıkları görmemeleri amacıyla başka bir mekana geçilir, birer kalem ve atık kağıt verilerek akıllarında kalan katı atıkları yazmaları istenir. En çok sayıda aklında katı atık kalan öğrencinin yanıtlarını okuması istenir. Mekana gidilerek atık türleri kontrol edilir.
- (5 dk.) Oyun sonunda bu katı atıkların nelerden çıkmış olabilecekleri sorulur.

Uygulama 2 (55 dk.)

Açıklama: Uygulama 2 ile öğrencilerin, bir önceki derste ve Uygulama 1'de üzerinde konuştukları ve gözlem yaptıkları katı atıkları verilen bilgilendirme metninden yararlanarak sınıflandırmaları ve bunu tablo ile göstermeleri istenmektedir. Gruplar hazırladıkları sınıflandırmaları diğer gruplara sunarken tartışma ortamının oluşması ve öğretmenin bir kolaylaştırıcı olması istenmektedir. Öğretmenin, Ön Bilgi bölümü başta olmak üzere çeşitli kaynaklardan yararlanarak konuya hakim olması ve öğrencilere doğru sorular sorması, iyi bir öğrenme kolaylaştırıcısı olması açısından önemlidir. Öğrencilere yaptıkları sınıflandırmalarda hataların olabileceği ve grupların bu tür durumlarda tablolarında değişiklikler yapabilecekleri söylenir, sınıflandırmada metne dayanarak

gerekçeli düşünmeleri sağlanır. Sınıflandırma aşamasından sonra ise öğrencilerden tablolaştırdıkları verilerden sonuç çıkarmaları beklenmektedir.

- Öğrenciler gözlem yaptıkları gruplarıyla çalışmaya devam ederler.
- (20 dk.) "Katı Atıklar Her Yerde" isimli 1.etkinliğinin sonunda öğretmen tarafından toplanan ve gezdikleri mekanlardaki katı atık isimlerini yazdıkları "Ek 1: Katı Atıklarımı Sınıflandırıyorum" çalışma kağıdı gruplara geri verilir. Her bir gruba "Ek 2: Bilgilendirme Metni" dağıtılır ve projeksiyondan da sunum yansıtılır. Gözlem yaptıkları yerlerde çöpe atılan ve gözlem formuna kaydettikleri katı atıkları metinde verilen atık türlerine göre sınıflandırmaları istenir.
- (5 dk.) Örnek olması açısından Uygulama 1'de kullanılan bir katı atığın hangi atık türüne ait olduğu bilgilendirme metnine bakılarak birlikte bulunur.

KATI ATIKLARIMI SINIFLANDIRIYORUM

Adım-Soyadım:	
Neyi gözlemledim?	Gözlem yaptığım yerde çöpe atılan nesneleri(atıkları)
Gözlem yaptığım yer	
Gözlem Tarihim:	
Gözlem Saatim (aralık)	

	Nesnenin adı	Nerede bulunduğu	Evsel atık	Tıbbi atık	Endüstriyel atık	Tarımsal atık	Tehlikeli atık	Elektronik atık	Madeni yağ atıkları	Bitkisel yağ atıkları
1										
2										
3										
4										
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6										
7										
8										
9										
10										

Gözlemlerime dayanarak elde ettiğim sonuç:

Aynı yerde gözlem yapan tüm grup üyelerinin gözlemlerine dayanarak elde ettiğimiz sonuç:

- (15 dk.) Öğrencilerden "Ek 1: Katı Atıklarımı Sınıflandırıyorum" çalışma kağıdını doldurduktan sonra gözlem kayıtlarına dayanarak bir sonuç çıkarmaları istenir. Örn: …. Saatleri arasında…….yaptığım gözlemde, en fazla …..atık çıkarken, en az…..çıktı. Sonra aynı yere giden diğer arkadaş/arkadaşlarıyla bir araya gelerek o yerde yapılan tüm gözlem kayıtlarını inceleyerek bir grup yorumu yazarlar.
- (15 dk.) Her grup bir sözcü seçer ve yaptıkları çalışmayı nedenleriyle açıklar. Grupların gözlem formları ayrı ayrı zımbalanarak toplanır.

Değerlendirme (15 dk.)

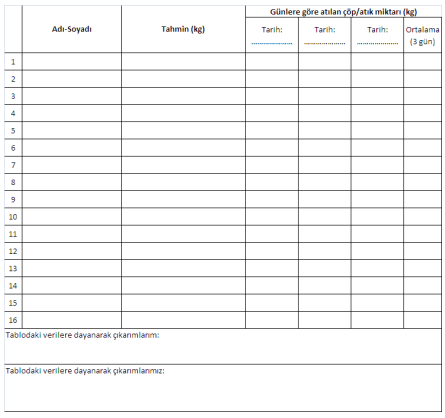
Açıklama: Değerlendirme olarak adlandırılan bu bölümde her öğrencinin konuyla ilgi edindikleri bilgi sorgulanmaktadır.

- (5 dk.) Her bir öğrenciye "Ek 3: Değerlendirme İçin Çıkış Kartı" çalışma kağıdı verilir. Makine hurdası, ağaç dalları, kullanılmış süt şişesi, hazır çorbanın paketinin hangi tür atık grubuna girdiklerini bulmaları ve çıkış kartındaki tabloda ilgili alana yazmaları istenir. Öğrenciler bu süreçte isterlerse gözlem formundaki atık türlerinin isimlerine bakabilirler. ***[Yanıt:*** *"Makine hurdası-endüstriyel atık, ağaç dalları-tarımsal/organik atık, kullanılmış süt şişesi-evsel katı atık, hazır çorbanın paketi-evsel katı atık]*
- (10 dk.) Çalışmanın sonunda bugün neler öğrendikleri öğrencilere sorulur ve yanıtları alınır.

Bir sonraki etkinlik için hazırlık

Açıklama: Bu bölüm; katı atıkların dışarıda bir yerlerde, sadece başkaları tarafından üretilmediği; öğrencinin bizzat kendisinin de farklı miktarlarda katı atık ürettiğini fark etmesi amacıyla tasarlanmıştır.

- Öğrencilerden sabah kalktıktan akşam yatana kadar günlük olarak çöpe attıkları atıklarını (organik atıklar dahil), herhangi bir çöp kutusuna atmak yerine yanlarında taşıyacakları bir poşete toplam üç gün süresiyle atmaları istenir. Her gün için ayrı bir poşet kullanmaları istenir. Örneğin; sabahları içtikleri süt kutuları, elma çöpü, bisküvi paketleri, eskiyen ve çöpe atacakları çorap, meyve kabukları, ekmek paketi. Öğretmen de benzer çalışmayı kendi atıkları için yapacağını söyler. Gerekirse poşetler önceden öğretmen tarafından üzerinde her öğrencinin adı-soyadı ve tarih yazacak şekilde 3'er tane hazırlanır ve öğrencilere verilir.
- Söz konusu yönerge öğrencilere verildikten sonra; öğrencilerden çalışmadan ayrılmadan önce günlük ortalama kaç gr/kg katı atık ürettiklerini tahmin etmeleri istenir, tahminleri "Ek 4: Günlük kaç kg. katı atık atıyorum?" çalışma kağıdına not edilir. Tahminlerini neye göre yaptılarını düşünmeleri istenir.



	Adı-Soyadı	Tahmin (kg)	Günlere göre atılan çöp/atık miktarı (kg)			
			Tarih:	Tarih:	Tarih:	Ortalama (3 gün)
1						
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Tablodaki verilere dayanarak çıkarımlarım:						
Tablodaki verilere dayanarak çıkarımlarımız:						

“Etkinlik 2: Katı Atıkları Sınıflandırıyorum” isimli etkinlik sonunda;

Öğrencinin katı atıkların insanlar tarafından farklı boyut ve çeşitlerde üretildiğini fark etmeleri; gözlemledikleri katı atıkları belirlenen ölçütler çerçevesinde küçük/büyük grup tartışmaları yoluyla sınıflandırmaları; sınıflandırdıkları bilgileri tablo ile göstermeleri ve tablodan sonuç çıkarmaları sağlanacaktır. Bu yolla “F.7.4.5.4. Yakın çevresinde atık kontrolüne özen gösterir.” Kazanımına ulaşmak için bir adım oluşturulmuştur.

Ek 1: Katı Atıklarımı Sınıflandırıyorum

KATI ATIKLARIMI SINIFLANDIRIYORUM										
Adım-Soyadım:										
Neyi gözlemledim?	Gözlem yaptığım yerde çöpe atılan nesneleri(atıkları)									
Gözlem yaptığım yer										
Gözlem Tarihim:										
Gözlem Saatim (aralık)										
	Nesnenin adı	Nerede bulunduğu	Evsel atık	Tıbbi atık	Endüstriyel atık	Tarımsal atık	Tehlikeli atık	Elektronik atık	Madeni yağ atıkları	Bitkisel yağ atıkları
1										
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10										
Gözlemlerime dayanarak elde ettiğim sonuç:										
Aynı yerde gözlem yapan tüm grup üyelerinin gözlemlerine dayanarak elde ettiğimiz sonuç:										

Ek 2: Bilgilendirme Metni

Kullanım süresi dolan ve yaşadığımız ortamdan uzaklaştırılması gereken maddelere "katı atık" denir. Katı Atık halk dilinde çöp olarak bilinir. Katı atıklar evde, okulda, hastanede, endüstride, bahçelerde ve daha birçok yerde oluşabilir. Katı atıklar yani çöpler herkesin her gün ürettiği ve daha sonra bunlardan kurtulmak istediği şeylerdir.

Her türlü atık ve artığın çevreye zarar verecek şekilde, doğrudan veya dolaylı bir biçimde alıcı ortama verilmesi, depolanması, taşınması, uzaklaştırılması ve benzeri faaliyetlerin yasaklanması gerekmektedir. Çevreyi olumsuz yönde etkileyebilecek olan katı atıkların idaresinin belli bir disiplin altına alınması sağlanmalıdır. Havada, suda ve toprakta kalıcı etki gösteren kirleticilerin hayvan ve bitki nesillerini, doğal zenginlikleri ve ekolojik dengeyi bozmasının önlenmesi gerekmektedir.

Katı Atık Türleri Nelerdir?

Evsel Atıklar: Konutlarda, okullarda, iş yerlerinde vb. yerlerde ortaya çıkan, içlerinde tehlikeli ve zararlı madde içermeyen atıklara “evsel atıklar” denir. Evsel atıklar içerisinde yer alan ambalaj atıkları ile ilgili detaylı bilgiye ileriki bölümlerde değinilecektir.

Tıbbi Atıklar: Hastane, klinik ve muayenehane gibi sağlık ve tedavi merkezlerinde oluşan atıklar ile kullanılmış ilaç, ilaç şişesi, şırınga, vb. tıbbi malzemeler, ameliyat ve tedavi sırasında oluşan atıklar tıbbi atıklara örnek verilebilir.

Endüstriyel Atıklar: Sanayi ve üretim tesislerinde bir işlem sırasında veya sonrasında ortaya çıkan katı atıklara “endüstriyel katı atıklar” denir. Örnek olarak: Maden ve taş ocaklarından kaynaklanan atıklar, gıda üretimi sırasında oluşan atıklar, odun, ahşap vb. malzemelerin üretimi ve başka bir malzeme üretimi için kullanılması sırasında meydana gelen atıklar,

Tarımsal Atıklar: Tarım sırasında oluşan ve yaprak, dal, sap, saman, kök vb. atıklara “tarımsal atık” denir.

Tehlikeli Atıklar: Sanayiden ve çeşitli üretim tesislerinde ortaya çıkan insan ve çevre sağlığına zarar verecek olan atıklara 'tehlikeli atıklar' denir. Örneğin; pil, boya, akü ve çeşitli kimyasallar.Atık Piller: kağıt, metal, cam ve plastik gibi atıklardan daha az hacme sahip olmasına rağmen, binlerce kat fazla ağır metal içerirler.

Elektronik Atıkları: Kullanım ömrünü tamamlamış olan elektrik ve elektronik cihazlara ‘elektronik atık’ denir. Bu atıklara örnek olarak; bilgisayar, yazıcı, tarayıcı, faks vb. atıklar verilebilir.

Madeni Yağ Atıkları: Madeni yağlar, mekanik ekipmanlarda yağlama görevini yerine getiren petrol ürünleridir. Madeni yağlar kullanıldıktan sonra tehlikeli atık sınıfına girerler. Tehlikelilik karakteri nedeniyle madeni yağ atıklarının denize, göle, akarsulara, toprağa verilmesi son derece sakıncalıdır.

Bitkisel Yağ Atıkları: Bitkisel kökenli ve kullanım amacına uygun olarak piyasaya arz edilen gıda yağlarına ‘bitkisel yağlar’ denir. Örnek olarak; evlerde kullanıldıktan sonra oluşan yağ atıkları, yağ üretim işlemi olan rafinasyon sonrası oluşan atık yağlar, rafinasyon tanklarında kalan tortular vb. verilebilir.

Öğrenciler için kaynak: Çevre Koruma ve Ambalaj Atıklarını Değerlendirme Vakfı (ÇEVKO) (2012). Gelecek için Geri Dönüşüm Eğitmen El Kitabı, sayfa 7-9.

Ek 3: Değerlendirme İçin Çıkış Kartı

Adı ve Soyadı :

Atık adı	Atık türü
Makine hurdası	
Ağaç dalları	
Kullanılmış süt şişesi	
Hazır çorbanın paketi	

Ek 4: Günlük Kaç Kg Katı Atık Atıyorum?

	Adı-Soyadı	Tahmin (kg)	Günlere göre atılan çöp/atık miktarı (kg)			
			Tarih:	Tarih:	Tarih:	Ortalama (3 gün)
1						
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Tablodaki verilere dayanarak çıkarımlarım:						
Tablodaki verilere dayanarak çıkarımlarımız:						

APPENDIX J: CODEBOOK FOR INTERVIEW QUESTIONS

Parent code	**Code**
General opinion about program	Positive
General opinion about program	Undecided
Recommend program to others	Yes
Recommend program to others	Partially
	General environmental awareness
	Recommend program to others
	Affective disposition toward environment
	Environmental problem solving
Recommend program to others	No
	Reason for recommending program
	Environmentally responsible behavior
	Recommendations for program
Regional background	Rural
Regional background	Urban
	Regional background
	Attitude towards recovery
	General opinion about program
General opinion about program	Negative
	Knowledge gains about packaging waste recovery