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FOSTERING ENVIRONMENTAL AWARENESS IN PRIMARY SCHOOL STUDENTS: EVALUATING THE IMPACT OF A WASTE MANAGEMENT EDUCATION PROGRAM

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Abstract:
This study investigates the environmental knowledge and perceptions of primary school students in Greece, emphasizing critical gaps in waste management awareness and sustainability within the context of Greece's efforts to align with the European Union's Circular Economy Action Plan. The research examines students' understanding of fundamental concepts such as waste types, recycling, and sustainability while also assessing the impact of a targeted educational intervention. The intervention consisted of a structured teaching session supplemented by an engaging creative activity, where students designed posters to celebrate World Environment Day, fostering environmental literacy through experiential learning. The findings revealed initial gaps in students' knowledge, especially regarding sustainability and organic waste. However, the intervention significantly enhanced their understanding, particularly in linking sustainability to economic, societal, and environmental factors, and fostered a sense of personal responsibility for waste reduction. This research underscores the pivotal role of targeted, experiential interventions in primary education, advocating for their integration into formal curricula to cultivate environmental stewardship and advance global sustainability goals. It highlights the need for integrating experiential learning and environmental education into school curricula to better prepare students for addressing global sustainability challenges. The study offers important insights for educators,

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policymakers, and curriculum developers in designing effective programs to enhance environmental literacy.

Keywords: environmental education, sustainability, waste management, primary education

1. Introduction

Sustainable development is an evolving concept that seeks to balance economic growth, social equity, and environmental stewardship (United Nations, 2015). In Greece, addressing persistent challenges in waste management and aligning with the European Union's Circular Economy Action Plan remain critical for advancing these goals. Effective waste management plays a pivotal role in mitigating environmental and public health challenges caused by improper disposal and inefficient resource use (Ghisellini, Cialani, & Ulgiati, 2016; Kirchherr, Reike, & Hekkert, 2017). Waste management is increasingly viewed through the lens of the circular economy, which emphasizes reducing waste, reusing materials, and recycling resources to create closed-loop systems (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). In the context of Greece, a nation striving to meet European Union waste management targets, significant challenges persist, particularly in aligning local practices with the goals of the Circular Economy Action Plan (European Commission, 2020).

Environmental education plays a pivotal role in cultivating sustainability consciousness, with secondary education teachers occupying a central position in this endeavor (Ferguson, Roofe, & Cook, 2021). In Greece, environmental education is primarily implemented through extracurricular activities rather than as a formalized curriculum component, limiting its potential to instill sustainability values systematically. The alignment of waste management practices with the European Union's Circular Economy Action Plan remains a pressing challenge, further highlighting the importance of educational interventions to instill sustainable behaviors from an early age (Armakolas, Robolas, Karachalios, Anastopoulou, & Gomatos, 2019; Karachalios, Plakitsi, *et al.*, 2023).

This study investigates the environmental knowledge, attitudes, and behavioral intentions of 6th-grade students in Greece, with a particular focus on their understanding of waste management, the concept of sustainability, and the role of individual responsibility. The main aim is to assess the impact of a targeted educational intervention on these students' knowledge and attitudes. The intervention incorporates principles of experiential learning, which have been shown to enhance environmental awareness and engagement (Karachalios, 2024b).

The study evaluates various parameters, including students' understanding of key waste-related concepts (e.g., organic waste, composting, recycling symbols, landfill hazards) and their perceptions of waste management methods, the role of individuals, and the influence of technology in solving waste-related issues. Additional factors such

as the socioeconomic status of parents, prior participation in environmental education programs, and the correlation between general environmental knowledge and specific waste-related understanding, are also analyzed to provide a comprehensive picture of the influences shaping students' environmental literacy.

Building on prior research that emphasizes the role of innovative teaching strategies in sustainability education (Armakolas *et al.*, 2019; Karachalios, 2024b), this study contributes to the growing body of evidence highlighting the importance of early educational interventions.

2. Literature Review

2.1 Environmental Education and Sustainability

Environmental education (EE) is recognized globally as a crucial mechanism for fostering sustainability awareness and promoting environmentally responsible behaviors. Defined as an educational process that cultivates individuals' understanding, attitudes, and behaviors concerning the environment, EE is essential for addressing complex global challenges, such as climate change, biodiversity loss, and waste management (Stevenson, Brody, Dillon, & Wals, 2013; UNESCO, 1977). Integrating EE into primary education has garnered significant attention as an effective strategy for instilling sustainability values at an early stage. Research has shown that students exposed to sustainability education early are more likely to develop lifelong habits aligned with environmental stewardship (Gough, 2002).

In Greece, EE has been introduced primarily through extracurricular activities and short-term programs rather than as a formalized part of the curriculum (Goussia-Rizou & Abeliotis, 2004). Despite these efforts, challenges persist, including limited teacher training, insufficient resources, and inadequate integration into core subjects.

2.2 Waste Management Education

Waste management education is a vital component of EE, focusing on instilling the principles of reduce, reuse, and recycle while building waste literacy. Waste literacy encompasses an understanding of waste concepts, such as decomposition times and recycling processes, and their environmental impacts (European Commission, 2020). Globally, initiatives like the Circular Economy Action Plan advocate for integrating waste management education into school curricula to foster resource efficiency and reduce waste generation. In Greece, the limited formal inclusion of waste education remains a barrier, often leaving its implementation to individual schools and educators (Karachalios, Kalavrouziotis, *et al.*, 2023). Digital tools have also emerged as valuable resources in waste management education. For instance, gamified platforms and interactive digital resources can promote sustainable practices and improve environmental awareness among students (Karachalios, 2024a).

Globally, efforts to integrate waste management education into school curricula vary widely. In Europe, the Circular Economy Action Plan emphasizes the need for

education systems to promote circular economy principles, with a focus on reducing waste generation and enhancing resource efficiency (European Commission, 2020). In Greece, however, the inclusion of waste management education remains limited, often relying on the initiative of individual schools and teachers. Studies have shown that while awareness exists among educators, systemic support is necessary for more consistent and impactful implementation (Karachalios, Kalavrouziotis, *et al.*, 2023).

2.3 Interventions for Enhancing Waste Literacy

Short-term educational interventions are widely regarded as effective for addressing specific gaps in students' environmental knowledge and attitudes. Interactive and experiential strategies, such as group projects, gamified learning activities, and creative tasks, are particularly impactful in fostering engagement and deeper understanding (Fischer *et al.*, 2023). Research underscores the importance of these methods, demonstrating that even brief interventions can lead to significant improvements in students' environmental knowledge and behaviors (Armakolas *et al.*, 2019). The role of teacher facilitation and the integration of real-world applications, such as field trips to recycling centers, further enhances the impact of these interventions (Ferguson *et al.*, 2021).

2.4 Gaps and Contributions

While advancements in environmental education have been made globally, significant gaps persist, particularly in the integration of waste management education into formal curricula. In Greece, challenges such as insufficient teacher training, limited resources, and the absence of systemic support hinder the consistent delivery of environmental education (Goussia-Rizou & Abeliotis, 2004). This reliance on extracurricular activities limits the potential for long-term behavioral changes and fails to address key knowledge deficits.

3. Material and Methods

3.1 Study Design and Framework

This study examines the environmental knowledge and perceptions of primary school students in Greece, focusing on waste management and sustainability. Conducted at the 26th Primary School of Patras, the research aimed to assess the effectiveness of a brief educational intervention in fostering environmental literacy and promoting sustainable behaviors. The intervention aligns with the objectives of environmental education (EE) outlined in the Belgrade Charter, which underscores the need for fostering values that promote sustainability and responsible behavior in younger generations (Tilbury, 1995; UNESCO, 1976).

The research problem stems from Greece's standing as one of the lowest-ranked countries in the European Union regarding waste management performance. According to Eurostat (2020), 82% of municipal waste in Greece is disposed of in landfills, compared

to an EU average where 42% of municipal waste is recycled or composted. This underscores the critical need for effective educational interventions to raise awareness and promote sustainable waste management practices among younger generations (Ghisellini *et al.*, 2016).

3.2 Study Sample

The sample consisted of 21 sixth-grade students (11 boys and 10 girls) from the 26th Primary School of Patras. This age group was chosen due to its critical developmental stage, where students begin to form more complex views on environmental issues. The school was selected as it represents typical urban primary schools in Greece, providing a relevant context for understanding the challenges of embedding environmental education in local curricula. Although 76% of students reported engaging in basic household recycling, their exposure to structured environmental programs was minimal.

3.3 Data Collection Methods

Data were collected using a structured questionnaire, carefully designed to assess students' knowledge, attitudes, and perceptions of waste and sustainability. This tool was selected for its efficiency in capturing a wide range of information within a limited timeframe (Bell, 1997). The questionnaire combined open-ended questions to explore students' spontaneous definitions of terms like 'organic waste' and 'sustainability,' closed-ended Likert-scale items to measure their agreement with statements about waste management, and multiple-choice questions to evaluate factual knowledge. Such a comprehensive approach ensured a robust analysis of both cognitive and attitudinal dimensions (Bryman, 2016).

Open-ended questions explored students' definitions of key terms, such as "organic waste," "sustainability," and "landfill," allowing for a deeper understanding of their spontaneous knowledge and thought processes (Bryman, 2016). Closed-ended questions, on the other hand, employed a 5-point Likert scale to measure levels of agreement with various statements about waste management, a widely accepted method for assessing attitudes and perceptions in environmental education research (Kyriazi, 1998; Likert, 1932). Multiple-choice and true/false questions were included to evaluate students' factual knowledge, such as their ability to identify recyclable materials and their understanding of the decomposition times of various types of waste, reflecting the importance of knowledge-based assessments in shaping pro-environmental behavior (Bell, 2014; Evans, Otto, & Kaiser, 2018).

3.4 Teaching Intervention

The intervention comprised a brief, interactive teaching session aimed at introducing key concepts such as waste reduction, recycling, and sustainability. This was immediately followed by a hands-on creative activity, where students designed posters for World Environment Day. The session incorporated elements of experiential learning, known for enhancing student engagement and fostering a deeper understanding of environmental

topics (Sterling, 2011). This approach aligns with prior research that highlights the effectiveness of creative, participatory activities in promoting environmental awareness and behavior change (Evans *et al.*, 2018; Karachalios, 2024b). The intervention aimed to reinforce the importance of individual and collective actions in addressing waste-related challenges.

3.5 Data Analysis

Data analysis combined both quantitative and qualitative methods to provide a comprehensive understanding of students' environmental knowledge and perceptions. Open-ended responses were coded into thematic categories to identify recurring patterns and gaps in understanding (Braun & Clarke, 2006). Likert-scale items were analyzed using descriptive statistics, with averages and percentages calculated to reveal prevailing attitudes toward waste management. Quantitative results were then triangulated with qualitative findings to ensure a nuanced interpretation of the data (Creswell & Clark, 2017). Microsoft Excel was utilized to manage and analyze the dataset efficiently.

3.6 Research Ethics and Limitations

Participation in the study was voluntary, and all necessary permissions were obtained from the school principal, teachers, and parents. While the study focused on a single primary school, its findings provide critical insights into the potential of targeted interventions to improve environmental literacy in similar urban educational settings. Participation was entirely voluntary, and all required permissions were secured from the school principal, teachers, and parents. Ethical considerations included ensuring student anonymity and maintaining transparency throughout the research process.

4. Results and Discussion

This section presents the findings derived from the statistical analysis of the data collected through student questionnaires. This section presents the key findings derived from the analysis of data collected through student questionnaires, shedding light on their environmental knowledge, attitudes, and behaviors concerning waste management. Additionally, it evaluates the effectiveness of the targeted teaching intervention and creative activity in enhancing environmental literacy and promoting sustainable practices among primary school students.

4.1 Knowledge of Key Concepts

4.1.1 Understanding Waste and Sustainability

The first question explored students' understanding of fundamental concepts, including waste, liquid and solid waste, and sustainability. Before the intervention, only 33% of students associated waste with "useless materials/objects." Post-intervention, this percentage doubled to 67%, with an additional 9% linking waste to "reuse." Notably, prior to the intervention, no students could define sustainability; however, post-intervention,

57% identified it as the intersection of society, economy, and environment. These results highlight the effectiveness of the intervention in promoting a clearer conceptual understanding of sustainability, aligning with previous research emphasizing the importance of experiential learning in fostering environmental knowledge (Evans *et al.*, 2018; Karachalios, 2024b).

Table 1: Changes in Understanding of Concepts Related to Waste Management Pre & Post-Intervention

Theme	Pre-Intervention (%)	Post-Intervention (%)
Sustainability definition	0.0	57.0
Waste as 'useless materials'	33.0	67.0
Importance of 'reuse'	0.0	9.0

4.2 Focus on Waste Reduction vs. Recycling

In the second question, 57% of students initially considered recycling more important than reducing waste, compared to 33% who prioritized reduction. Students showed a preference for recycling over waste reduction, with the majority prioritizing recycling both before and after the intervention. This stability in perception suggests that while the intervention improved conceptual knowledge, a deeper focus on waste reduction is needed to shift attitudes toward a more holistic understanding of sustainability. Incorporating real-life examples of waste reduction, such as the principles highlighted in the Circular Economy Action Plan (European Commission, 2020), could address this gap in future interventions.

4.3 Attitudes Toward Waste Management

4.3.1 Changes in Perceptions Post-Intervention

Students' attitudes toward various waste management scenarios were assessed using a series of Likert-scale questions. The results showed incremental improvements in key areas post-intervention:

A. Perceived Ability to Identify Recyclable Materials

Initially, 71.4% of students agreed that it is easy to identify recyclable materials in waste. This percentage increased slightly to 76.2% post-intervention, suggesting some improvement in confidence but highlighting the need for more detailed instruction in this area.

B. Responsibility for Waste Management

Before the intervention, 71.4% of students disagreed with the statement that only authorities, not individuals, should manage waste. This percentage rose slightly to 76.2% after the intervention, reflecting a modest shift toward recognizing individual responsibility.

C. Belief in Individual Action

A significant improvement was observed in students agreeing with the statement, "My personal actions can contribute to proper waste management." Agreement increased from 62% to 75%, a 13% rise, indicating the intervention's success in fostering a sense of personal agency.

Table 2: Changes in Perceptions Post-Intervention

Question	Pre-Intervention (%)	Post-Intervention (%)	Change (%)
Recognizing recyclable materials	71.4	76.2	4.8
Defining sustainability	0.0	57.0	57.0
Belief in personal contribution to waste management	62.0	75.0	13.0

D. Support for Government Regulations and Corporate Responsibility

Students were initially divided on whether industries should be required to use recycled materials, even if it costs more. Agreement dropped slightly from 52.4% to 42.9% post-intervention. This may reflect a perception of economic trade-offs associated with stricter environmental regulations, an issue that aligns with broader societal debates on balancing economic and environmental priorities (European Commission, 2020).

4.3.1 Behavioral Intentions and Actions

4.3.1.1 Creative Activities and Environmental Engagement

The creative activity, involving poster-making for World Environment Day, played a key role in reinforcing environmental messages. Before the intervention, 76.2% of students believed that actions like beach cleanups or proper disposal in recycling bins contributed to environmental protection. Post-intervention, this percentage rose to 85.7%, underscoring the value of engaging in hands-on activities in promoting pro-environmental behaviors (Sterling, 2011).

4.3.2 Knowledge Outcomes

4.3.2.1 Performance on Knowledge-Based Questions

Students' performance on knowledge-based questions demonstrated modest improvement post-intervention. Prior to the intervention, 48.6% of responses were correct, increasing slightly to 50.4% afterward. Key findings include:

A. Recognizing Recyclable Materials

Students exhibited a strong understanding in this area, with over 80% correctly identifying recyclable items both before and after the intervention.

B. Understanding Organic Waste

This area posed the greatest challenge, with only 38% of students correctly identifying organic waste both pre- and post-intervention, despite targeted teaching efforts. This

result highlights the complexity of the topic and the need for more in-depth instructional approaches.

5. Discussion

5.1 Effectiveness of the Teaching Intervention

The intervention effectively enhanced students' understanding of basic waste management concepts, particularly sustainability and individual responsibility. However, its impact on knowledge retention and certain attitudes, such as the importance of waste reduction and recognition of organic waste, was limited. These findings align with existing research that highlights the need for repeated and multifaceted educational interventions to achieve long-term changes in environmental knowledge and behavior (Evans *et al.*, 2018; Tilbury, 1995).

5.2 Implications for Environmental Education Programs

The results underscore the importance of incorporating both cognitive and experiential elements into environmental education programs. While brief interventions can improve awareness and engagement, achieving significant and sustained changes in attitudes and behaviors requires ongoing reinforcement through curriculum integration and community involvement (Gough, 2002; UNESCO, 2015).

6. Recommendations

Based on the findings of this study, the following recommendations are proposed to enhance environmental education and promote sustainable waste management practices among primary school students:

6.1 Integration of Environmental Education into the Core Curriculum

To ensure lasting impact, environmental education (EE) should be systematically integrated into the formal school curriculum rather than being offered as an optional or extracurricular activity. Lessons on waste management, sustainability, and environmental ethics should be included in science, social studies, and other relevant subjects. Aligning these lessons with the principles of the circular economy and sustainability goals will help students develop a deeper understanding of their role in addressing environmental challenges (Ghisellini *et al.*, 2016; UNESCO, 2017; Γομάτος *et al.*, 2018; Καραχάλιος, 2023).

6.2 Emphasis on Experiential Learning

Hands-on, interactive activities such as recycling workshops, poster-making, and community cleanup projects should be prioritized. These activities have been shown to effectively engage students and reinforce environmental knowledge and skills, as demonstrated by the success of the creative intervention in this study. Schools should

partner with local organizations, waste management companies, and environmental NGOs to provide experiential learning opportunities (Karachalios, 2024b; Sterling, 2011).

6.3 Teacher Training and Professional Development

Teachers play a central role in shaping students' environmental attitudes and behaviors. Professional development programs should equip educators with the knowledge, skills, and resources to effectively deliver environmental education. Workshops, seminars, and training sessions should focus on innovative teaching methodologies, including experiential learning and gamification (Armakolas *et al.*, 2019; Karachalios, 2024b; Karachalios, Kalavrouziotis, *et al.*, 2023). Empowering teachers with up-to-date information and strategies will enhance the quality of EE programs.

6.4 Targeted Interventions for Specific Knowledge Gaps

The study revealed specific gaps in students' understanding, such as their difficulty identifying organic waste and their limited awareness of the importance of waste reduction compared to recycling. Future educational interventions should address these gaps through targeted lessons and real-world examples. For instance, composting projects could help students understand organic waste, while case studies on reducing consumption could highlight the importance of waste reduction (Evans *et al.*, 2018).

6.5 Family and Community Involvement

Promoting environmental responsibility requires a holistic approach that extends beyond the classroom. Schools should actively involve families and local communities in environmental education initiatives. For example, parent workshops on sustainable household practices, student-led community recycling drives, and school-community partnerships for environmental projects can amplify the impact of these programs (Gough, 2005; UNESCO, 2015).

6.6 Continuous Assessment and Feedback Mechanisms

To improve the effectiveness of environmental education programs, it is essential to regularly assess their impact and gather feedback from students, teachers, and other stakeholders. Tools such as follow-up surveys, reflection exercises, and focus groups can help educators identify areas for improvement and adapt their strategies accordingly. Continuous evaluation will ensure that programs remain relevant and impactful over time (Bryman, 2016).

6.7 Policy Support for Environmental Education

National and local education authorities should prioritize policy measures that promote environmental education. This includes allocating funding for EE programs, incorporating EE as a mandatory component of teacher training, and incentivizing schools to adopt innovative sustainability initiatives. Strong policy support will create an enabling environment for long-term change (European Commission, 2020).

6.8 Raising Awareness on Waste Reduction

While recycling is often emphasized, it is equally important to teach students about reducing waste at its source. Educational programs should highlight practical ways to minimize waste, such as reducing single-use plastics, making sustainable consumer choices, and understanding the environmental impact of waste generation. These efforts should align with global sustainability frameworks like the United Nations Sustainable Development Goals (UN SDGs) (United Nations, 2015).

By implementing these recommendations, schools and educators can enhance the effectiveness of environmental education programs and empower students to adopt sustainable practices. A coordinated effort involving educators, families, communities, and policymakers is essential to instill environmental responsibility in young learners and address pressing challenges in waste management and sustainability.

7. Conclusion

It is widely acknowledged that the impacts of environmental challenges significantly affect quality of life and exacerbate social inequalities (Friel, Marmot, McMichael, Kjellstrom, & Vågerö, 2008; United Nations, 2015). These issues are not merely technological but reflect a deeper crisis of values and human behavior, highlighting how individuals perceive their role within ecosystems and cultural value systems (Tilbury, 1995). A shift in societal values can provide the motivation for transformative societal change, fostering social justice and well-being (McMichael, 2012). Therefore, it is essential to reframe lifestyles and behaviors by developing an ethical framework that emphasizes respect for all forms of life and cultivates environmental responsibility (Sterling & Orr, 2001).

In today's rapidly advancing society, characterized by technological innovation and accelerated social change, the need for adaptation is paramount. Education plays a pivotal role in this context, serving as a vehicle to raise awareness about environmental issues and promote a culture of sustainability. This culture not only adds value to environmental knowledge but also fosters critical thinking, creativity, and the skills necessary to address environmental challenges from a systemic perspective (Buckler & Creech, 2014; Sterling, 2011). Through the acquisition of knowledge and competencies, individuals are better prepared to navigate and thrive amid these shifts. Continuous education and professional development are crucial, especially for educators who are responsible for guiding future generations and must remain updated on advancements in science and pedagogy (UNESCO, 2017).

This research was driven by the increasing need for studies in this field. The primary aim was to explore and compare the environmental knowledge and attitudes of sixth-grade students at the 26th Primary School of Patras. The study assessed the impact of a 15-minute targeted teaching intervention and a creative activity, such as poster-making for World Environment Day, on students' knowledge and perceptions regarding waste management.

The findings reveal significant gaps in students' understanding of core concepts, such as solid waste, wastewater and sustainability (Karachalios, Plakitsi, Hatzinikita, & Kalavrouziotis, 2021). However, these gaps were considerably reduced after the intervention, demonstrating the effectiveness of brief educational activities in enhancing environmental literacy. While the intervention had a notable impact on improving students' knowledge, their environmental attitudes showed less significant change, suggesting that shifting perceptions may require more extended or differently structured interventions (Evans *et al.*, 2018).

An especially promising result was the increased belief among students in their ability to contribute to waste management solutions through personal and collective actions. Prior to the intervention, 62% of students believed they could make an individual impact, and 81% emphasized the importance of collective effort. Post-intervention, these perceptions increased by over 10%, highlighting the potential of targeted educational approaches to foster a sense of agency and responsibility.

This study demonstrates that targeted, creative teaching interventions can significantly improve students' environmental knowledge and attitudes. These findings align with research emphasizing the importance of interactive learning in fostering environmental responsibility among young learners (Leicht, Heiss, & Byun, 2018). However, the study also underscores the need for more comprehensive, long-term approaches to environmental education, particularly in cultivating deeper conceptual understanding in areas such as waste reduction and organic waste management (Jensen & Schnack, 2006). Addressing these gaps requires integrating sustainability topics into formal curricula and providing continuous learning opportunities (Monroe, Andrews, & Biedenweg, 2008).

Future programs should emphasize hands-on and community-based learning activities that connect students to real-world environmental challenges. Approaches such as service learning, environmental audits, and localized waste management projects have been shown to enhance student engagement and foster meaningful change (Ballantyne & Packer, 2009). Such activities align with global frameworks, including the UN's Education for Sustainable Development (ESD) initiative, which highlights the role of education in addressing sustainability challenges (Rieckmann, 2018).

In conclusion, brief but focused teaching interventions on waste management, coupled with creative activities like poster-making or recycling projects, hold the potential to create significant positive impacts on students' environmental literacy. By promoting awareness of personal and collective responsibility, these methods encourage students to adopt sustainable practices and recognize their role in addressing global environmental challenges (Orr, 1994).

This study offers valuable insights for educators, policymakers, and curriculum developers seeking to enhance environmental education's effectiveness. By embedding sustainability themes into primary education, society can cultivate a generation prepared to address critical sustainability issues with the skills and mindset required for transformative action (Sterling, 2011).

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