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PATHWAYS TO ZERO WASTE: PROSPECTIVE SCIENCE TEACHERS' SOLUTIONS THROUGH EVERYDAY LIFE SCENARIOS*

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Abstract

The aim of the study is to examine prospective science teachers' awareness of zero waste management through their responses to scenarios based on everyday life problems, and to identify their solution proposals. The study was conducted using a qualitative case study design. The study group consisted of 28 prospective science teachers enrolled at a state university in Turkey during the 2024–2025 academic year. Data were collected through a scenario-based open-ended form. The data were analyzed using inductive content analysis. The results revealed that participants' solution proposals mainly focused on recycling, waste reduction at the source, reuse, composting, social awareness, and institutional regulations. Responses to the scenarios showed that zero waste practices were not limited to individual responsibility but also involved social cooperation, infrastructure arrangements, economic incentives, and educational processes. Participants emphasized that environmentally responsible behaviors are shaped not only by personal intentions and attitudes but also by social norms, perceived behavioral control, and institutional support. In conclusion, prospective science teachers demonstrated awareness of zero waste management and developed concrete solution proposals through everyday life-based

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scenarios, emphasizing the importance of scenario-based approaches in teacher education.

Keywords: *Zero waste, zero waste management, everyday life scenario, prospective science teachers, case study.*

SIFIR ATIĞA GİDEN YOLLAR: ÖĞRETMEN ADAYLARININ GÜNLÜK YAŞAM SENARYOLARI ÜZERİNDEN ÇÖZÜMLERİ

Öz

Araştırmanın amacı, fen bilgisi öğretmen adaylarının günlük yaşam problemlerine dayalı senaryolara verdikleri yanıtlar aracılığıyla *sıfır atık yönetimine ilişkin farkındalıklarını incelemek ve bu problemlere yönelik geliştirdikleri çözüm önerilerini belirlemektir. Çalışma, nitel durum çalışması deseni kullanılarak gerçekleştirilmiştir. Çalışma grubu, 2024-2025 akademik yılında Türkiye'deki bir devlet üniversitesine kayıtlı 28 fen bilgisi öğretmen adayından oluşmuştur. Veriler, senaryo temelli açık uçlu form aracılığıyla toplanmış ve tümevarımsal içerik analizi kullanılarak analiz edilmiştir. Sonuçlar, katılımcıların çözüm önerilerinin ağırlıklı olarak geri dönüşüm, kaynağında atık azaltma, yeniden kullanım, kompostlama, sosyal farkındalık ve kurumsal düzenlemelere odaklandığını ortaya koymuştur. Senaryolara verilen yanıtlar, sıfır atık uygulamalarının bireysel sorumlulukla sınırlı olmadığını, aynı zamanda sosyal işbirliği altyapı düzenlemeleri, ekonomik teşvikler ve eğitim süreçlerini de içerdiğini göstermiştir. Katılımcılar, çevreye duyarlı davranışların sadece kişisel niyet ve tutumlarla değil, aynı zamanda sosyal normlar, algılanan davranış kontrolü ve kurumsal destekle de şekillendiğini vurgulamışlardır. Sonuç olarak, fen bilgisi öğretmen adayları günlük yaşam temelli senaryolar aracılığıyla sıfır atık yönetimine ilişkin farkındalıklarını ortaya koymuş ve somut çözüm önerileri geliştirmiştir. Bu durum, öğretmen eğitiminde senaryo temelli yaklaşımların önemini vurgulamaktadır.*

Anahtar Kelimeler: *Sıfır atık, sıfır atık yönetimi, günlük yaşam senaryoları, fen bilgisi öğretmen adayları, durum çalışması.*

1. INTRODUCTION

Population growth leads to increased consumption of resources to meet food, energy, and other basic needs, which in turn significantly increases waste generation. Uncontrolled practices such as incineration or direct disposal of waste into the environment cause air, water, and soil pollution, resulting in adverse environmental impacts (Özcan, 2023). Today, the volume, diversity, and environmental impacts of waste are rapidly increasing and reaching increasingly hazardous levels (Çavdar et al., 2014). Global environmental problems compel societies to develop urgent and lasting solutions within the framework of sustainability. Because waste generation and management are directly linked to individual habits, they constitute a critical problem area for environmental sustainability (United Nations Environment Programme [UNEP], 2025). In natural processes, waste is observed to serve as an input for other environmental components; this understanding has encouraged the adoption of a circular economy approach instead of a linear economy and has led to the development of the "zero waste" strategy (Bilgili, 2021). In this context, the zero waste approach is a holistic waste management strategy that treats waste as a resource and can be applied to various stakeholders, from companies to households. This approach serves environmental protection, cost reduction, and sustainable development goals, aiming to reduce resource consumption and ensure sustainable prevention and management of waste (Hamid et al., 2020).

The term zero waste was first introduced in the mid-1970s with the establishment of the Zero Waste Systems Institute by chemist Paul Palmer (Sönmez, 2020). Zero waste aims to prevent wastefulness, review the causes of waste generation, reduce or eliminate waste at its source, promote sustainable

product choices, ensure the efficient use of resources, and recover waste through source separation when it occurs (Official Gazette of the Republic of Türkiye, 2019). Moreover, zero waste is not merely a technical practice but a lifestyle that requires fundamental changes in individuals' daily lives. This lifestyle represents a comprehensive approach that encourages conscious waste separation, consumption limited to actual needs, participation in recycling processes, and the adoption of environmentally responsible consumption habits (Çalışkan, 2020). Although it is often regarded as synonymous with recycling, zero waste prioritizes refusing, reducing, and reusing waste before recycling. This approach proposes five steps: refuse, reduce, reuse, recycle, and rot (Johnson, 2013). Within the framework of the 5R principles, these steps aim to promote a more sustainable lifestyle and reduce environmental impacts (Rustan et al., 2023). However, there are various challenges in integrating zero waste practices into daily life. The widespread adoption of this process depends not only on individual intentions but also on social habits, infrastructural capacity, and regulatory frameworks. Research indicates that despite positive individual intentions, waste generation continues due to entrenched social practices and inadequate regulations (Zhan, 2022). In this context, the main barriers to adopting a zero waste lifestyle are deficiencies in infrastructure, knowledge, and social support (Tran, 2019). However, the effective dissemination of this approach within society requires individuals to possess environmental awareness.

Considering the relationship between the programs in which prospective science teachers are educated and environmental education, as well as the nature of course content, they are expected to develop a high level of environmental awareness and sensitivity (Torun, Aydemir & Gül, 2023). In this context, prospective teachers can promote environmental behavior change by transferring their environmental knowledge and awareness to their students.

Therefore, the views of prospective science teachers on environmental issues directly related to real life—such as zero waste—and particularly on solution proposals for everyday life problems are of significant importance. Examining prospective teachers' awareness regarding zero waste practices and how they evaluate these practices within the framework of daily life problems can contribute to the quality and effectiveness of environmental education. Such problems can be considered an important tool for integrating environmental education into individuals' everyday experiences.

Everyday life problems are complex situations that are ill-structured, require interdisciplinary knowledge, and involve thinking and application processes aimed at solving real-world issues with which individuals can directly relate (Jonassen, 2000). These problems generally arise in daily life and require the application of knowledge acquired through formal education to generate solutions (Savransky, 2000). Unlike school-based problems, they may not have a single correct answer and can involve multiple disciplinary domains (Jonassen, 2000). In this respect, everyday life problems are important for the development of students' interdisciplinary knowledge use, decision-making, and critical thinking skills. Science education, in turn, aims to build a bridge between scientific knowledge and everyday life (National Research Council, 2012).

The literature indicates that although prospective teachers hold positive attitudes toward environmental issues, they experience difficulties in translating these attitudes into everyday practice (Bal, 2015; Çelik & Güler, 2013). This situation highlights the need to integrate real-life–related environmental topics, such as zero waste, more holistically into teacher education programs (Herman & Nur, 2024). Teachers assume significant responsibilities in fostering environmental awareness and promoting ecological

citizenship. Since environmental topics are embedded in science curricula, the role of science teachers is particularly prominent in this process (Koca & Çobanoğlu, 2024). Teachers play an effective role in disseminating environmental awareness throughout society via individuals (Goldman et al., 2021). Moreover, teachers are key actors in instilling sustainability values and enhancing environmental sensitivity through environmental education (Akarsu, Yılmazer & Geçit, 2020; Harman & Yenikalaycı, 2020). Science teachers, in particular, bear substantial responsibility for teaching environmental issues and cultivating zero waste awareness among students. Therefore, higher education institutions should support the development of environmentally sensitive prospective science teachers and encourage the adoption of zero waste principles (Bayar, 2017).

Educating prospective science teachers in line with zero waste awareness and sustainable living principles contributes to the development of responsible production and consumption habits among students and supports sustainable development goals. By raising awareness of recycling and modeling positive behaviors, prospective teachers play a crucial role in the dissemination of zero waste practices (Aksan & Çelikler, 2019). Studies indicate that in science courses, success in transferring school-taught problems to everyday life is limited, leading to a widening gap between academic achievement and real-life competence (Gürel et al., 2003; Demirci, 2014). While prospective teachers and students tend to perform well on routine problems, they demonstrate insufficient success in solving everyday life problems (Bal, 2015; Çelik & Güler, 2013). Research also shows that daily actions and lifestyle choices have significant impacts on environmental problems. Integrating sustainable practices into everyday life enables individuals to recognize the relationship between personal habits and environmental issues (Tuntiya, 2022). Practices such as waste reduction and energy conservation provide substantial

environmental benefits (Ardoin & Heimlich, 2021). In addition, locally implemented initiatives enhance community participation, support collective action on environmental issues, and foster a culture of sustainability (Li, 2020). Addressing everyday life problems related to environmental issues allows individuals to recognize not only personal sustainability but also environmental justice and the effects of global processes on the biosphere (DiChiro, 2009). In this context, developing solution skills for everyday life problems within the framework of zero waste is expected to increase environmental awareness and strengthen the connection between learned knowledge and real-life contexts.

The literature indicates that studies addressing prospective teachers' solution proposals and perspectives on zero waste through everyday life scenarios are limited. Existing research has largely focused on the place of zero waste within curricula and on conceptual and theoretical knowledge (Altınok, 2021; Bilgili, 2021). In contrast, studies addressing perceptions, cognitive structures, and attitudes toward zero waste have predominantly relied on quantitative data collection methods (Atmiş & Dilek, 2024; Dal & Akçay, 2021; Seyhan, 2024; Ulusal & Küçükkendirci, 2023). In addition, research examining curricula and textbooks (Canata Çöklü & Alkan, 2023; Önal, Kaya & Çalışkan, 2019), studies focusing on zero waste attitudes and perceptions (Özcan, 2023), and regulatory frameworks addressing zero waste policies (Official Gazette of the Republic of Türkiye, 2019) are prominent in the literature. In a study based on teacher perspectives, Altıntaş, Özdinç, and Ceyhan (2026) found that teachers' knowledge of sustainable development and zero waste was limited. However, they recognized the need for training in these areas. The literature also indicates that prospective science teachers have insufficient awareness of the zero waste approach (Harman & Yenikalaycı, 2020). Solution proposals developed through everyday life scenarios can support prospective teachers in adopting a more informed approach to zero waste practices and in providing

effective instruction to students on this issue. Indeed, perceptions of waste types within the scope of recycling (Harman & Çelikler, 2016) and understandings of the aims of zero waste projects (Erten & Atmaca, 2021) can be more clearly revealed through scenario-based approaches. This, in turn, enables the education of qualified teachers who can help disseminate zero waste awareness.

Unlike previous studies that mainly focused on attitudes, perceptions, or curriculum-based evaluations of zero waste, this study uniquely examines prospective science teachers' awareness and solution proposals through everyday life-based scenarios. The aim of the study is to examine prospective science teachers' awareness of zero waste management through their responses to scenarios based on everyday life problems, and to identify their solution proposals.

1. How do prospective science teachers reflect their awareness of zero waste management and develop solution proposals through their responses to everyday life-based scenarios?

2. METHOD

This study was conducted using a case study design. A case study enables an in-depth and detailed examination of a specific phenomenon or event within its real-life context and allows researchers to reveal participants' thoughts and behaviors in authentic situations, together with diverse perspectives and solution proposals (Merriam & Tisdell, 2016; Yin, 2018). In this study, the case study approach was preferred because prospective teachers' awareness of zero waste, reflected in their responses to scenarios based on everyday life problems, and their solution proposals were examined in depth. In this study, awareness was not treated as a psychometric construct measured by a scale;

rather, it was interpreted qualitatively based on participants' scenario-based explanations, evaluations, and solution proposals.

2.1. Study Group

The study group consisted of 28 prospective science teachers enrolled at a public university in Türkiye during the 2024–2025 academic year. Participants were included on a voluntary basis and were selected from the 2nd, 3rd, and 4th year levels. Of the participants, 19 were in their fourth year, 6 in their third year, and 3 in their second year; 18 were female, and 10 were male. The sample was determined using a convenience sampling method, comprising prospective teachers who were accessible to the researcher and volunteered to participate.

2.2. Data Collection Tool

Data were collected using a scenario-based open-ended form. The form included five scenarios focusing on situations that may be encountered in daily life within the scope of zero waste and aimed to elicit teacher candidates' views in detail. The scenarios were associated with the 5R approach, including recycling, reducing consumption, reuse, and the management of organic waste. Data were gathered through a scenario-based open-ended form developed by the researcher and administered via Google Forms, which included demographic information and zero waste–themed daily life problem scenarios. The data collection process lasted approximately two weeks; participants were invited online on a voluntary basis and completed the form at their convenience. The responses obtained were systematically organized for analysis.

2.3. Data Analysis

The data obtained from the study were analyzed using inductive content analysis, a qualitative data analysis technique. This method aims to identify latent patterns and relationships in texts without prior assumptions (Stoltz & Taylor, 2023). The inductive content analysis process involves open coding, abstraction of codes, and the development of categories and themes to reach conceptual structures (Elo & Kyngäs, 2008). During the analysis, participant responses were examined in detail; open codes were generated from the statements; these codes were grouped into categories; and the categories were further organized into themes. The process was conducted inductively; codes, categories, and themes were reviewed comparatively with an expert researcher and revised until consensus was reached. Although initial differences of opinion emerged regarding the placement of some codes, discussions led to consistent alignment of codes within appropriate categories.

2.4. Validity and Reliability

The content and structural validity of the data collection tool were evaluated through expert review and a pilot implementation, and necessary revisions were made accordingly. To ensure the validity and reliability of the data, teacher candidates' responses were coded using inductive content analysis, with the coding process conducted comparatively by the researcher and an independent expert. Presenting the data systematically through tables and visual representations supported the transparency of the analysis. Direct quotations from participants' responses were also included below each table. These practices are consistent with recommendations for establishing validity

and reliability in qualitative research (Miles, Huberman & Saldaña, 2014; Lincoln & Guba, 1985).

3. RESULTS

"Scenario 1. Recycling Bins: *You notice that your university has recycling bins of different colors for glass, plastic, paper, and metal waste. However, you observe that some students throw the wrong waste into the recycling bins, while others do not use the recycling bins at all."* This situation was presented to prospective teachers, and the findings from this scenario are shown in Table 1.

Table 1. Findings Related to the "Recycling Bins" Scenario

Theme	Category	Code	(f)
Informing and Awareness	Informing	Explaining the importance of waste management	6
		Organizing conferences	4
		Raisinig consciousness	4
		Orginasing seminars	3
		Providing training	3
		Informing the local community	3
		Explaining the waste management process	2
		Making announcements	2
		Posting on the university's social media/boards	1
	Awareness	Raising awareness with visual materials	13
		Increasing the visibility of waste bins	5
		Lack of awareness	4
		Organizing awareness campaigns	2
		Demonstrating the environmental damage through posters	2
		Instilling environmental awareness at an early age	1
Motivation mechanisms	Social control	Encouraging proper waste separation	5
		Preventing incorrect waste disposal through warnings	4
		Encouraging people to warn each other	3
		Warning students about incorrect disposal	1
		Forming volunteer groups	1
	Incentive	Rewarding correct waste disposal	5

	mechanisms	Organizing inter-faculty competitions	2
		Installing pay-per-waste machines	2
		Paid shifts for waste separation	1
		Digitization	1
		Sensor alerts for incorrect disposal	1
Insufficiencies in the current practices	Lack of waste separation knowledge	Students not understanding recycling bin symbols	2
		Making symbols understandable	2
		Perception that recycling bins do not lead to actual recycling	2
		Non-use of recycling bins	1
Enhancing implementation effectiveness	Physical arrangement	Providing recycling infrastructure in classrooms	2
		Removing existing trash cans	1
		Separating recycling and trash bins	1
		Placing bins in accessible locations	1
	Institutional support	Involving the school administration	1
	Sustainability	Ensuring the sustainability of recycling bins	1

Table 1 shows that the prospective teachers' suggestions fall under four main themes: *"Information and awareness," "Motivation mechanisms," "Insufficiencies in the current practices,"* and *"Enhancing implementation effectiveness*". Under the theme of *informing and awareness*, prospective teachers focused on “informing” and “awareness activities”. Under the theme of *motivation mechanisms*, prospective teachers drew attention to social control and incentive mechanisms. Prospective teachers also emphasized that there were some *insufficiencies in the current practices*. In particular, the lack of waste separation knowledge, the incomprehensibility of the symbols on the recycling bins, and the ineffective use of recycling bins were highlighted. Under the theme of *enhancing implementation effectiveness*, physical arrangement, institutional support, and sustainability stood out.

P4:” We can encourage the use of recycling bins by removing other trash cans because students may want to throw things away in the trash cans near them. They should be digitized because they can make them more interesting.”

"Scenario 2. Waste Management in My Neighborhood: *On your way to school in the morning, you see a lot of food scraps, empty boxes, and bottles around the trash containers placed by the municipality in your neighborhood. As an environmentally conscious citizen, you call the local administration to report the situation in order to find a solution to this problem without harming the environment."* This situation was presented, and the findings are shown in Table 2.

Table 2. Findings Related to "Waste Management in My Neighborhood"

Theme	Category	Code	(f)
Physical arrangements in waste management	Design and placement of containers	Placing of recycling bins in neighborhoods/homes	7
		Placing separate bins for food waste	5
		Using smart sensors	3
		Placing large/lidded containers	2
		Using separate containers for waste	2
		Reporting the fill level to authorities using QR codes, etc.	2
		Placing animal pictures on recycling bins	1
		Designing glass waste containers so that animals cannot access them	1
		Adding a lid to the bottom of the container	1
		Incorporating a grinding mechanism inside the container	1
		Designing containers that can only be opened by hand	1
		Developing waste collection systems	1
	Container management	Emptying containers more frequently	9
		Increasing the number of containers	7
		Increasing the number of cleaning crew	1
Social responsibility	Consciousness-raising activities	Use of visual information materials	4
		Explaining the importance of recycling	3
		Management informing municipalities	3
		Creating awareness about proper waste disposal on social media	2
		Raising awareness through neighborhood meetings	2
		Raising awareness among university students	1
		Educating community leaders and encouraging	1

		them to raise public awareness	
		Organizing conferences for students/families in collaboration with schools	1
		Studying human behavior	1
		Providing education to the neighborhood community	1
	Behavioral guidance	Placing warning signs	4
		Forming a community in the neighborhood to warn those who do not follow the rules	2
		Promoting recycling	1
		Ensuring that the neighborhood community attaches importance to waste separation	1
		Ensuring that the neighborhood community complies with the rules through warning notices	1
		Making trash collection fun	1
		Conducting awareness talks with family elders	1
		Ensuring public participation	1
	Incentives	Organizing clean neighborhood competitions	2
		Developing reward systems	2
		Organizing environmental cleanup days	1
Supervision and sanctions	Sanctions	Imposing penalties on those who violate the rules	6
		Introduction of strict rules	1
		Identifying polluters and imposing sanctions	1
	Supervision	Ensuring that each household is responsible for its own waste container	2
		Prohibiting waste disposal after a certain time	2
		Monitoring with camera systems	1
		Filing a complaint with the municipality if trash is not collected	1
		Tighten inspections	1
		Assign a trash collection supervisor	1
		Ensuring regular inspections by cleaning staff	1

In Table 2, suggestions fall under three main themes: *"Physical arrangements in waste management," "Social responsibility,"* and *"Monitoring and sanctions."* Under the theme of *physical arrangements in waste management*, prospective teachers made suggestions regarding the design, placement, and management of containers. Under the theme of *social responsibility*, prospective teachers drew attention to consciousness-raising activities and behavior guidance practices. Under the theme of *supervision and sanctions*, prospective teachers

drew attention to sanctions and supervision practices. Within the scope of sanctions, imposing penalties on those who violate the rules came to the fore. Within the scope of supervision, practices such as ensuring that each household is responsible for its own waste container and prohibiting waste disposal after a certain hour stood out. However, it was also noted that a smaller number of participants made original suggestions, such as placing animal pictures on recycling bins, incorporating a grinding mechanism inside the container, making trash collection fun, and organizing clean neighborhood competitions.

P1: "Instead of placing a single trash container in neighborhoods, there could be a separate container for food waste, which could even be designed so that animals can easily feed on it. There could also be a separate trash container for glass, which I think should be designed so that animals cannot see it."

***"Scenario 3. The Electronic Devices in the School:** In a school, it is determined that some of the smart boards, computers, photocopiers, and printers in use are very old, and some do not even work. The school administration, which is very sensitive to zero waste management, does not want these devices to be discarded, but also considers that purchasing new devices would be costly."* This situation was presented, and findings from this scenario are shown in Table 3.

Table 3. Findings Related to the "Electronic Devices in the School" Scenario

Theme	Category	Code	(f)
Sustainable waste management	Recycling	Recycling old devices	9
		Send to electronic waste	3
		Recycling functional parts	2
		Sending metal waste for recycling	1
		Separating waste and sending it for recycling	1
		Collaboration with technological recycling companies	1
	Repair	Repair	13
		Replacing damaged parts	1
	Exchange/rene	Using the "bring the old one, take the new	2

	wal	one" program	
		Exchanging with manufacturers	1
		Exchanging old materials with another sector	1
		Exchanging with repairers	1
		Replacing device parts	1
	Reuse	Using for another purpose	1
		Reusing old devices after refurbishment	1
		Reuse through repair	1
		Separating devices that can be reused	1
		Using functional parts in other devices	1
	Reduction	Preventing the generation of electronic waste	2
		Preventing devices from becoming waste	1
		Achieving zero waste	1
	Extending the service life	Using devices that are not too outdated for a certain period	1
	Currency	Adhering to technological standards	1
Cost management	Savings	Cost reduction	10
		Using the savings for acquiring new devices	6
		Planning usage based on financial situation	1
	Resource provision	Collaborating with institutional/local support	2
		Leasing through technology companies	1
		Establishing subscription agreements	1
		Requesting the purchase of new machines	1
		Obtaining support from graduates/parents	1
		Creating funds for new devices using revenue from recycling	1
Social responsibility	Sharing	Sending repaired devices to village schools	2
		Cooperating with other schools/municipalities	2
Education	Awareness	Instilling awareness of efficient use among students/teachers	1

In Table 3, solutions were grouped under four main themes: "Sustainable waste management," "Cost management," "Social responsibility," and "Education." Under sustainable waste management, participants focused particularly on recycling, repair, exchange/renewal, reuse, and reduction strategies. Under the theme of cost management, the category of savings has come to the fore. Under the theme of social responsibility, while under the theme of education, the idea of instilling awareness of efficient use among students and teachers stands out. Among the suggestions voiced by fewer participants are using functional parts in other devices, collaboration with technological recycling

companies, exchanging old materials with another sector, adhering to technological standards, and receiving support from graduate students.

P15: "Used technological devices can be repaired; this way, high costs are avoided when purchasing new devices. Exchanges can be made by reaching agreements with manufacturers."

"Scenario 4. I am Shopping at the Supermarket: *While shopping at a supermarket, you notice that a lot of plastic bags are used to carry products. As someone who is aware of the environmental damage caused by plastic bag use, you want to make some recommendations to the supermarket owner about not using plastic bags."* This situation was presented, and findings from this scenario are shown in Table 4.

Table 4. Findings Related to the "I am Shopping at the Supermarket" Scenario

Theme	Category	Code	(f)
Reducing plastic use	Use of alternative bags	Encouraging the use of cloth/paper/mesh bags	12
		Suggesting biodegradable/soluble bags	3
		Recommending of reusable bags	3
		Ensuring the availability of cloth bags in supermarkets	2
		Distributing hand-knitted bags in stores	1
		Replacing plastic bags with less harmful packaging	1
	Economic measures	Charging fees for bags	4
		Increasing bag fees to reduce usage	3
		Reducing the cost of cloth bags	3
		Making eco-friendly bags cheaper to encourage preference	1
	Reuse	Reusing bags in different areas	2
		Using reusable bags	2
		Using cloth bags by converting them into different items	1
		Recycling worn-out bags for reuse	1
		Reusing old bags	1
	Incentives/rewards	Offering discounts to customers who bring	2

		cloth bags	
		Offering discounts/rewards for using reusable bags at the store	1
		Rewarding customers who exceed a certain spending amount	1
	Recycling	Offering recyclable paper bags for sale	4
	Mandatory applications	Mandatory use of cloth bags	1
		Limiting customers' requests for extra bags	1
		Banning plastic bags in supermarkets	1
	Brand sustainability	Strengthening brand image by producing eco-friendly bags with the market logo	2
	Technological solution	Developing vending machines that exchange plastic bags for cloth bags	1
Consciousness raising	Awareness	Informing about the harms of plastic bags	3
		Raising customer awareness on the use of eco-friendly bags	2
		Organizing zero waste awareness events with municipalities/environmental associations	1
	Visual materials	Displaying visuals at checkout to show the environmental damage of bags	1
	Staff training	Training cashiers to ask “Would you like a bag?” before giving one	1
Environmental protection	Waste reduction	Reducing plastic bag usage	4
		Preventing plastic bag usege	3

In Table 4, solutions were grouped under three main themes: *"Reducing plastic use," "Consciousness raising," and " Environmental protection."* Under the theme of *reducing plastic use*, participants particularly emphasize the use of alternative bags. Under the theme of *consciousness-raising*, participants focused on awareness. Under the theme of *environmental protection*, participants emphasized strategies such as waste reduction.

P17: "Customers can be offered reusable cloth bags, nets, or paper bags as alternatives. The market offers an environmentally friendly option by producing cloth bags with its own logo”.

"Scenario 5. Zero Waste in My Kitchen: *You noticed that your friend, with whom you share a house in the city where you go to university, throws away fruit and vegetable waste in the kitchen while preparing meals and afterward."* This situation was presented, and the findings are shown in Table 5.

Table 5. Finding Related to Zero Waste in My Kitchen Scenario

Theme	Category	Code	(f)
Waste management	Reuse	Making animal feed from waste	7
		Giving waste to stray animals	3
		Making new meals from edible waste	2
		Using waste with lemon/vinegar for cleaning	2
		Using vegetable peels to make herbal tea	1
		Reusing recycled materials	1
		Producing pastries/fruit juice from clean leftovers	1
	Compost / natural fertilizer	Converting waste into natural fertilizer	14
	Recycling	Returning waste to nature	4
		Directing toward recycling	4
	Waste reduction	Buying vegetables/fruits according to need	2
		Chop fruits/vegetables in a way that prevents waste	1
	Separating waste	Preparing a plan to categorize waste	1
		Collecting organic waste in a separate location	1
Benefits	Ecological benefit	Contributing to nature	11
		Providing food for animals	7
		Preventing waste from going to landfill	5
		Increasing soil fertility	2
		Supporting plant growth	2
		Preventing littering in nature	1
		Reducing the use of plastic cleaning products	1
	Social benefit	Sharing with people in need	1
		Donating to farms or animal shelters	1
	Saving	Avoiding unnecessary spending	1
Consciousness raising	Informing	Informing about the uses of waste	2
		Information about preventing food waste	2
		Sharing videos/articles natural decomposition of organic waste	1
		Explaining the importance of recyclable materials	1

	Developing behavior	Developing a habit of flower care	1
		Developing eco-friendly living habits	1
		Promoting the use of recyclable products	1
Activities	Community participation	Participation in university/municipal organic waste collection projects	1
		Referral to local composting/recycling projects	1
		Disposing of waste in the municipal organic waste collection bins	1

Table 5 shows that the solutions of prospective teachers were grouped under four main themes: *"Waste management," " Benefits," " Consciousness raising,"* and "*Activities*." Under the *waste management* theme, prospective teachers drew attention to the reuse of waste, compost and natural fertilizer production, recycling, waste reduction, and waste separation. Under the theme of *benefits*, prospective teachers drew attention to ecological benefits, social benefits, and savings. Under the theme of *consciousness raising,* prospective teachers drew attention to the topics of informing, sharing, and developing behavior. Under the theme of *activities*, prospective teachers drew attention to community participation. Below is a direct quote from one prospective teacher's opinion.

P12: "If leftover food is edible, it should be stored and used in the next meal; if it is not edible, it can be put out for stray animals. This way, we take care of both ourselves and the animals."

4. CONCLUSIONS AND DISCUSSION

In this study, which examined prospective science teachers' awareness of zero waste and their proposed solutions through daily life scenarios, the findings obtained are as follows:

The results obtained from the first scenario indicate that prospective teachers emphasize the need to increase informational and awareness-raising activities on zero waste, establish mechanisms that support motivation, and address

existing deficiencies in order to implement recycling practices at universities effectively. The prospective teachers recommend instilling environmental awareness from an early age, supporting it with visual materials and awareness campaigns, implementing reward and social control mechanisms that encourage proper waste separation, placing recycling bins in accessible areas, and making symbols more understandable. Moreover, the active involvement of the school administration is a significant finding. Research indicates that environmental awareness influences pro-environmental behaviors, and perceptions of a university's environmental practices further enhance this effect (Eroğlu et al., 2025). The literature emphasizes that environmental behaviors are shaped not only by individual awareness but also by the regulation of environmental conditions (Geng & He, 2021; Yaban, 2025). Tangwanichagapong et al. (2017) reported that 3R practices on campuses increase environmental awareness, but voluntary approaches alone are insufficient for behavior change, and incentives reinforce the behavior. Similarly, Thoo et al. (2022) demonstrated that attitude, subjective norm, and perceived behavioral control positively affect recycling intention, which in turn is positively associated with actual behavior. However, the results indicate that these practices are generally based on individual awareness and are not implemented effectively. This situation aligns with insufficient information and awareness campaigns, a lack of motivation, and low implementation efficiency (Metzler, 2023; The Recycling Partnership, 2023). These results also suggest that scenario-based contexts may help prospective science teachers evaluate zero waste practices not only at the level of individual awareness but also in relation to institutional responsibility and implementation processes.

The results from the second scenario suggest that teacher candidates emphasize the need to address physical infrastructure, social awareness, and administrative regulations together for effective zero-waste management at the

neighborhood level. Appropriate design and placement of containers, monitoring of fill levels, regular collection of waste, and inspection mechanisms can establish a sustainable and efficient system when supported by information and awareness campaigns. Creative incentives and competitions enhance public participation, thereby strengthening management effectiveness. Teacher candidates' attention to alternative products and legal restrictions indicates that awareness campaigns alone are insufficient and highlights the importance of policies and administrative decisions. Xia et al. (2023), in their meta-analysis, showed that behavioral interventions have limited effects on recycling and that individual awareness or incentives alone are insufficient. Systemic interventions, including education, environmental regulations, and campaigns, were found to have a greater impact. Wilson et al. (2025) emphasized that individual interventions are inadequate for sustainable waste reduction and that interventions at community and system levels, along with strengthened inter-stakeholder collaboration, are necessary. Hu et al. (2021), using the Theory of Planned Behavior (TPB), examined waste separation behavior in an international community and demonstrated that environmental education and rule-targeted policies effectively promoted individuals' positive intentions. These results support the view of teacher candidates that awareness campaigns alone are insufficient and that systemic support and administrative regulations are necessary. In this respect, scenario-based situations appear to support prospective teachers in interpreting zero waste practices within real-life social and administrative contexts.

The results from the third scenario indicate that the management of unused or outdated electronic devices in schools requires the simultaneous achievement of environmental sustainability and economic efficiency. Repairing devices, renewing their components, reintroducing them for reuse, and sending them for recycling not only prevents waste generation but also extends their service

life. From a cost-management perspective, securing resources through recycling revenues and institutional support is important, while from a social responsibility standpoint, transferring repaired devices to rural schools or other institutions holds significance. These practices produce social benefits in addition to environmental gains, contributing to educational equity. Thus, electronic device management becomes a process that holistically encompasses environmental sustainability, economic efficiency, and social responsibility. Reyna, Hanham, and Orlando (2024) emphasize that educational institutions typically replace computer technologies every 3–5 years, creating a significant e-waste problem. They propose the concept of "sustainable device literacy," suggesting that devices should be updated and reused rather than simply replaced. Similarly, the Computer Reuse Program conducted by Sánchez-Carracedo and López (2021) extends the lifespan of devices by having students repair broken computers and donate them to non-profit organizations, while also developing students' technical skills and awareness of social responsibility. These results indicate that scenario-based approaches may enable prospective teachers to evaluate zero waste practices from environmental, economic, and social perspectives simultaneously.

Results from the fourth scenario indicate that the combined implementation of individual awareness, economic incentives, and institutional regulations is effective in reducing plastic bag usage. Teacher candidates suggested that promoting alternative bags, charging for plastic bags or, subsidizing eco-friendly products, raising customer awareness, and implementing recycling practices together could lead to a significant reduction in plastic bag consumption. Technological solutions and brand policies may further support the sustainability of these practices. This highlights the importance of addressing zero-waste objectives through an integrated approach that combines economic and behavioral tools. Similar findings are reported in the literature. Papp &

Oramus (2025) argue that bag bans or fees can reduce plastic waste and environmental harm, but without policy change, the problem persists globally. Ilham & Oktanedi (2024) highlight that social norms, economic incentives, and education-based interventions can support environmentally friendly behaviors. Successful initiatives, such as the “Bye Bye Plastic Bags” campaign, have been effective in increasing community engagement and raising awareness. Lange et al. (2021) demonstrate that incentives based on societal benefit are also effective; for example, fast-food customers reduced bag usage by more than half when donations were made for each unused bag.

Results from the fifth scenario indicate that kitchen-generated fruit and vegetable waste can be managed sustainably through reuse, composting, organic fertilizer production, awareness-raising, and community collaboration. Utilizing waste in various ways, such as animal feed, cleaning, or new meals, and separating organic waste not only prevents food loss but also provides ecological, social, and economic benefits. Participation in community projects and adoption of environmentally friendly habits support the transformation of individual awareness into collective action. In this context, the integration of individual practices with societal engagement is crucial. The literature supports these findings. UNEP (2025) emphasizes that composting improves soil structure, increases water retention capacity, and supports biodiversity. Bekavac et al. (2025) state that bioactive compounds derived from food waste have both health and environmental value, potentially reducing disease risk due to their antioxidant properties and serving applications in the food, pharmaceutical, and cosmetic industries. Campbell et al. (2025) demonstrate that community-based composting programs increase participant awareness, reduce waste, foster appreciation for circular food systems, and support behavior change by enhancing individuals’ self-efficacy.

5. RECOMMENDATIONS

Based on the results of this study, several recommendations are proposed to support prospective science teachers' awareness of zero waste management, as reflected in their responses to everyday life-based scenarios, and to further develop their solution proposals related to daily life issues. It is recommended that teachers plan interdisciplinary instructional activities that integrate zero waste awareness with real-life environmental problems during the teaching process. Policymakers and educational authorities may develop regulations in curricula and teacher education programs that support zero waste principles and management. Greater emphasis may be placed on sustainability, environmental responsibility, environmental awareness, and zero waste principles at all levels of science education curricula. To promote the adoption of zero waste practices in universities, awareness campaigns, workshops, and local collaborations can be organized. Future research on zero waste is recommended to include larger samples and participants from different regions, encompassing teachers, teacher candidates, and students. In addition, data diversity may be enhanced through the use of mixed methods, including observation and interview techniques. Further studies are also suggested to examine the effects of zero waste practices across different grade levels, academic disciplines, and regional contexts.

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GENİŞLETİLMİŞ TÜRKÇE ÖZET

Küresel çevre sorunları, günümüz toplumlarını sürdürülebilirlik konusunda acil ve kalıcı çözümler üretmeye zorlamaktadır. Özellikle atık üretimi ve yönetimi, bireysel alışkanlıklarla doğrudan ilişkili olması nedeniyle çevresel sürdürülebilirlik bağlamında önemli bir problem alanı olarak öne çıkmaktadır (UNEP, 2025). Günlük yaşam problemleri, bireylerin gerçek hayatta karşılaştıkları sorunlara yönelik düşünme, değerlendirme ve çözüm üretme süreçlerini içeren karmaşık durumlardır (Jonassen, 2000). Bu problemler, öğrencilerin disiplinler arası bilgi kullanma, karar verme ve eleştirel düşünme becerilerini geliştirmeleri açısından önem taşımaktadır. Fen eğitimi ise bilimsel bilgi ile günlük yaşam arasında köprü kurmayı hedeflemektedir (National Research Council, 2012). Fen bilgisi öğretmen adaylarının pedagojik yeterlikleri ve çevresel farkındalık düzeyleri, çevre sorunlarının anlaşılması ve öğrencilerde çevresel sorumluluk bilincinin geliştirilmesi açısından kritik bir role sahiptir. Literatürde, öğretmen adaylarının çevresel konulara yönelik olumlu tutumlara sahip oldukları ancak bu tutumların günlük yaşam uygulamalarına yeterince yansımadığı belirtilmektedir (Çelik ve Güler, 2013; Bal, 2015). Bu durum, sıfır atık gibi gerçek yaşamla doğrudan ilişkili çevresel konuların öğretmen eğitimi süreçlerine daha bütüncül biçimde entegre edilmesini gerekli kılmaktadır. Bu araştırmanın amacı, fen bilgisi öğretmen adaylarının sıfır atık konusuna ilişkin farkındalıklarını ve çözüm önerilerini, günlük yaşam problemleri temelinde oluşturulan senaryolar aracılığıyla incelemektir. Bu doğrultuda, fen bilgisi öğretmen adaylarının sıfır atık ilke ve uygulamalarını günlük yaşam bağlamında ne ölçüde doğru anladıklarının ve bu uygulamalara yönelik çözüm yaklaşımlarının ortaya konması hedeflenmiştir. Araştırmada nitel araştırma desenlerinden durum çalışması deseni kullanılmıştır. Çalışma grubunu, bir devlet üniversitesinde öğrenim gören 28 fen bilgisi öğretmen adayı (18 kadın ve 10 erkek) oluşturmaktadır. Veriler, Google Form aracılığıyla çevrim içi olarak uygulanan senaryo temelli açık uçlu form ile öğretmen adaylarına iletilmiştir. Elde edilen veriler tümevarımsal içerik analizi yöntemiyle analiz edilmiştir.

Birinci senaryodan elde edilen sonuçlara göre, geri dönüşüm uygulamalarının etkinliğinin artırılmasında bilgilendirme ve farkındalık çalışmalarının güçlendirilmesi, motivasyon ve ödüllendirme mekanizmalarının oluşturulması, çevre bilincinin erken yaşlardan itibaren kazandırılması, sıfır atık uygulamlarının görsel materyallerle desteklenmesinin, farkındalık kampanyaları düzenlenmesinin önemini ortaya koymaktadır. Bu sonuçlar, çevresel davranışların yalnızca bireysel farkındalıkla değil, aynı zamanda kurumsal ve çevresel düzenlemelerle şekillendiğini vurgulayan literatürle uyumludur (Geng ve He, 2021; Eroğlu vd., 2025). Tangwanichagapong vd., (2017) tarafından yapılan bir çalışmada, kampüslerde uygulanan 3R (azaltma, yeniden kullanım ve

geri dönüşüm) girişimlerinin insanların çevresel farkındalıklarını artırdığı, ancak gönüllü yaklaşımların tek başına davranış değişikliği yaratmadığı ve teşvik tedbirlerinin geri dönüşüm ve atık yönetimi davranışlarını olumlu yönde etkilediği bulunmuştur. Bu bağlamda, öğretmen adaylarının önerileri —çevre bilincinin küçük yaşlardan itibaren kazandırılması, farkındalık kampanyaları ve görsel materyallerle desteklenmesi, sosyal kontrol ve ödüllendirme mekanizmalarının uygulanmasıliteratürde belirtilen davranışsal mekanizmaların önemini doğrulamaktadır.

İkinci senaryoyadan elde edilen sonuçlar, sıfır atık yönetiminde bireysel farkındalığın yanı sıra fiziksel altyapı, toplumsal bilinç ve yönetsel düzenlemelerin birlikte yürütülmesi gerektiğini göstermektedir. Konteyner tasarımı, yerleşimi, doluluk takibi ve denetim mekanizmalarının bilgilendirme çalışmalarıyla desteklenmesi sürdürülebilir bir sistemin kurulmasına katkı sağlamaktadır. Bu durum, davranışsal değişimin sistemsel destekle güçlendirildiğini ortaya koymaktadır (Xia vd., 2023). Pawelczyk vd., (2025), basit bir broşür müdahalesinin atık ayrıştırma hatalarını önemli ölçüde azalttığını ve bilgiye dayalı araçların, altyapı ve bilişsel kısıtlamalarla birlikte etkili bir strateji sunduğunu ortaya koymuştur. Bu sonuçlar, bireysel farkındalık ve bilgilendirme çalışmalarının, doğru tasarlandığında, sistemsel müdahalelerle birlikte yürütüldüğünde çevresel davranış değişikliğinde önemli bir rol oynayabileceğini göstermektedir.

Üçüncü senaryodan senaryodan elde edilen sonuçlar, elektronik atıkların yönetiminde çevresel sürdürülebilirlik ile ekonomik verimliliğin birlikte ele alınmasının önemi vurgulanmıştır. Cihazların onarılması, yenilenmesi ve yeniden kullanıma kazandırılması, atık oluşumunu azaltırken sosyal sorumluluk uygulamalarıyla toplumsal fayda sağlamaktadır. Reyna, Hanham ve Orlando (2024), eğitim kurumlarında 3–5 yılda bir yenilenen bilgisayarların elektronik atık sorununu artırdığını ve cihazların güncellenip yeniden kullanılmasını önermektedir. Benzer şekilde, Sánchez-Carracedo ve López (2021), onarım ve bağış yoluyla cihaz ömrünün uzatıldığını vurgulamaktadır.

Dördüncü senaryo senaryodan elde edilen sonuçlar, plastik poşet kullanımının azaltılmasında bireysel farkındalık, ekonomik teşvikler ve kurumsal düzenlemelerin eş zamanlı uygulanmasının etkili olduğunu göstermektedir (Ilham ve Oktanedi, 2024; Papp ve Oramus, 2025). Bununla birlikte Lange vd., (2021), plastik poşet kullanımının azaltılmasında doğrudan parasal teşvikler yerine toplumsal faydaya dayalı teşviklerin de etkili olabileceğini ortaya koymaktadır. Araştırmalarında, fast food restoranı müşterilerine kullanılmayan her plastik poşet için bir yardım kuruluşuna küçük bir bağış yapıldığında plastik poşet kullanımının yarıdan fazla azaldığı belirlenmiştir. Elde edilen sonuçlar

bireylerin çevre dostu davranışlara yönlendirilmesinde toplumsal yarar sağlayan teşviklerin de önemli bir mekanizma olabileceğini göstermektedir.

Beşinci senaryoya ilişkin bulgular ise mutfak atıklarının kompost ve doğal gübre üretimi yoluyla yeniden değerlendirilmesinin, topluluk iş birliği ve bilinçlendirme ile sürdürülebilir şekilde yönetilebileceğini ortaya koymaktadır (UNEP, 2025; Campbell vd., 2025). Bunun yanında konaklama sektöründe yapılan araştırmalar, menü tasarımı, atık ayrıştırma, geri kazanım ve kompostlama gibi döngüsel uygulamların gıda atıklarını azalttığını ve müşteriler arasında sürdürülebilir davranışları teşvik ettiğini ortaya koymaktadır (Cardenas, Schivinski ve Brennan, 2024). Sonuç olarak, literatür kompostlama ve döngüsel uygulamaların atık yönetimi ve çevresel sürdürülebilirlik açısından çok boyutlu faydalar sunduğunu açıkça göstermektedir.

Araştırma sonuçlarına göre, fen bilgisi öğretmen adaylarının sıfır atık farkındalığını artırmak için günlük yaşam problemlerine dayalı, disiplinler arası ve problem çözme odaklı etkinlikler önerilmektedir. Müfredat ve öğretmen eğitimi programlarında sürdürülebilirlik ve çevresel sorumluluk temalarına daha fazla yer verilmelidir. Üniversitelerde farkındalık çalışmaları desteklenmeli, farklı bağlamlarda nitel ve karma yöntemli araştırmalarla uygulamaların etkileri derinlemesine incelenmelidir.