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SECONDARY EDUCATION TEACHERS' VIEWS ON ISSUES RELATED TO WASTEWATER AND SOLID WASTE MANAGEMENT

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Abstract:
This research investigated the views of secondary education teachers in Greece regarding waste management. A questionnaire was administered to 332 in-service secondary education teachers from various specialties to collect data on their views related to their ability and willingness to implement waste management topics, knowledge of waste management terms, and prioritization of waste management actions. The findings

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revealed that secondary education teachers expressed a moderate to low level of ability to implement educational activities related to waste management, with a wide distribution of views. They express that they felt more confident in implementing Environmental Education Programs (EEP) related to solid waste management than wastewater management. Teachers showed interest in participating in and organizing environmental programs, particularly for solid waste management. While teachers demonstrated a moderate level of basic knowledge of waste management, their understanding varied across different topics. Some terms were well-known, while others were less familiar. Teachers had a limited understanding of waste management principles and struggled to correctly prioritize waste management actions, with a significant percentage prioritizing recycling over waste minimization. These findings highlight the need for further education and training for secondary education teachers in Greece regarding waste management and environmental education. Improvements are necessary to bridge the gap between teachers' knowledge and understanding of waste management principles. This study emphasizes the importance of integrating waste management topics into teacher education programs and providing ongoing professional development opportunities. This research contributes to the literature by identifying areas for improvement in environmental education practices among secondary education teachers in Greece. The findings provide insights for curriculum development and teacher training programs. Future research should evaluate the effectiveness of environmental education initiatives aimed at enhancing teachers' knowledge and understanding of waste management principles.

Keywords: waste management, education, teachers

1. Introduction

Sustainable development is an act of balance between economic growth, social equality, and environmental protection (WCED, 1987). A critical factor in this equilibrium is effective waste management, addressing both solid and water waste (Baud, Grafakos, Hordijk, & Post, 2001; Morrissey & Browne, 2004). The principle of waste education or waste literacy is vital, promoting an understanding of waste's environmental and health impacts. This study focuses on Greece, a country grappling with waste management challenges yet striving to meet the European Union's Circular Economy Action Plan (Eurostat, 2016).

Secondary education teachers play a key role in shaping students' environmental awareness, including waste management and so their views on related issues are valued as very important (Ferguson, Roofe, & Cook, 2021). This research investigates these teachers' views on waste management and on their readiness to teach waste management, along with the resources and training they need.

Even though there are debates about including waste management education in the already full curriculum, about the value of hands-on experiences, and whether waste management should be a standalone subject (Ifegbesan, 2010), more research is needed on these topics. This study aims to contribute to this discourse by offering insights into secondary school teachers' views on waste management issues.

2. Literature Review

The role of environmental education in promoting pro-environmental behavior among secondary education teachers has been a topic of research and discussion (Ajaps & McLellan, 2015; Palmer & Suggate, 1996). While positive attitudes towards the environment among secondary education teachers do not always translate into environmentally friendly behavior (Esa, 2010), studies suggest that individuals tend to behave in an environmentally responsible manner when they are sufficiently informed about environmental issues, motivated to act, believe in the effectiveness of their actions, and perceive minimal barriers to change (Eagly & Chaiken, 1993; Grob, 1995; Schultz & Zelezny, 1999). A research study supports a positive correlation between pro-environmental attitudes and behaviors (P. C. Stern & Oskamp, 1987). Additionally, studies highlight the importance of considering factors such as knowledge and behavior when evaluating attitudes (Stahlberg & Frey, 1991). Knowledge alone is insufficient for behavior change; however, a positive correlation has been observed between environmental knowledge and pro-environmental attitudes, with attitudes being associated with the development of sustainable behaviors (P. Stern, 2000).

Research suggests that sufficient environmental literacy of students can be achieved when educators themselves possess adequate knowledge (Tuncer et al., 2009). Furthermore, a significant number of school textbooks propose the application of new technologies as the sole solution to issues such as waste management, indicating inadequate efforts in the prevention or reduction of consumption (Álvarez García, Sureda Negre, & Comas Forgas, 2012). Other studies point out that slow processes, lack of teacher involvement in sustainability promotion, limited recognition of these activities in academic curricula, and lack of institutional support are potential barriers (Lazzarini, Pérez-Foguet, & Boni, 2018; Zamora-Polo & Sánchez-Martín, 2019).

In Greece, there is a deficiency in the initial pedagogical training of secondary education teachers, including those at the primary education level, regarding environmental education (Gomatos, 2015). Focusing on Education for Sustainable Development (ESD), it is evident that there is insufficient preparation of teachers in this field. The study programs for pedagogical departments in Greece do not emphasize the education of teachers in this area but merely present superficial and highly theoretical concepts related to sustainability (Armakolas, Kazana, & Mitroulia, 2020; Papadopoulou, Kazana, & Armakolas, 2020).

Research exploring the knowledge and attitudes of high school students in Greece towards waste management (Karachalios, Plakitsi, Hatzinikita, & Kalavrouziotis, 2021) made a comparative analysis with students in the UK, with the results indicating a lower level of knowledge concerning waste management among Greek students, while Greek students reported recycling less frequently and attributed less importance to waste management concepts compared to their UK counterparts.

Research exploring teachers' views of implementing innovative actions in school units, particularly within ESD programs, revealed that participating teachers primarily viewed ESD as an educational innovation and subsequently as environmental education (Nitsotoli, 2010). Their motivations for participating in such programs were linked to the innovative pedagogical nature of ESD and the need to address environmental issues (Nitsotoli, 2010).

Another study examined teachers' theories regarding environmental education (Daskolia, 2005). The study concluded that teachers predominantly perceive environmental education as a new form of education—an alternative, radical, and innovative pedagogical and didactic proposal—termed a "non-lesson". Within the consciousness of teachers adopting these approaches, environmental education is associated with humanistic interest, content, and educational practice. The role of teachers, as described in their personal theories, varies from guiding and coordinating to advising, assisting, motivating, and even evolving into an equal collaborator or student.

Regarding teachers' views on integrating the concept of circular economy as a subject in schools, research in Greece reveals a general lack of understanding about sustainable development and the circular economy. Although students and teachers demonstrate positive views toward introducing recycling-related actions, some are unaware of whether environmental education is being implemented in their schools (Zisi, 2021). Furthermore, there is support for the introduction of a separate subject focused on environmental education, starting from primary education (Zisi, 2021).

The existing literature highlights the complex relationship between environmental attitudes, knowledge, and behaviors among educators. It emphasizes the need for knowledge among teachers, recognition of their role, and the importance of institutional support to promote sustainability in education.

Though the literature review does provide valuable insights into the role of environmental education and its potential impact on teachers' attitudes and behaviors, several critical gaps emerge which this study aims to address. A key gap is the understanding of secondary education teachers' views of their ability and competence to implement waste management education. While there is evidence of positive attitudes and pro-environmental behavior correlations, the specifics concerning waste management in the Greek educational context are inadequately explored. The current literature focuses on teachers' views in general terms but lacks specificity concerning waste management, leaving room for deeper investigation into this vital area of environmental education.

In addition, the studies conducted on teacher involvement in sustainability promotion and environmental education programs largely discuss the barriers and potential motivators but rarely delve into teachers' actual experiences, views, and practices concerning waste management. As such, this study will explore teachers' views on their active participation in environmental programs focused on waste management, thereby adding a fresh dimension to the existing body of knowledge.

Also notable is the emphasis on the theoretical aspects of Environmental Education for Sustainable Development (ESD) in the Greek pedagogical curriculum. There appears to be a lack of integration of practical, actionable elements, particularly regarding waste management. This study, therefore, seeks to address this gap by examining the views of secondary school teachers regarding their practical knowledge, awareness, and actions related to waste management.

The originality of this research lies in its focus on a context-specific examination of secondary education teachers' views of their abilities and responsibilities concerning waste management. By highlighting teachers' understanding of their role in shaping environmentally conscious citizens, this study will provide novel insights into the existing education practices and may contribute to improving the strategies for incorporating effective waste management practices into the school curriculum. The study will provide fresh empirical evidence from Greece, thereby adding to the limited research on this specific topic and geographical context.

3. Material and Methods

As a result of the extensive literature review conducted, several crucial research questions have been identified related to secondary education teachers' views. What are the views of secondary school teachers on the level of their ability to implement educational topics on waste management? What are the views of secondary school teachers on their willingness to implement or organise Environmental Programmes on waste management? What is their level of knowledge related to waste management? These are the research questions of the study.

The present research was conducted using a questionnaire as the data collection tool. A structured questionnaire was developed by the author for the research, which included multiple-choice questions as well as questions using the 5-point Likert scale. Question 21, thought was developed based on previous research conducted (Kolbe, 2015). The questionnaire employed for this research was constructed by the author, primarily featuring novel questions. These inquiries were framed upon the fundamental environmental awareness and waste management topics that are part of the curriculum for Greek high school students aged 12-15. This is in alignment with the framework of Sustainable Education in middle schools, as mentioned in the educational guide (Fermeli, Roussomoustakaki-Theodoraki, Hatzikosta, & Gkaitlich, 2009). This design approach was taken to ensure the questionnaire addressed the research questions effectively.

The questionnaire selection as the data collection method was considered more effective for capturing the views of educators' views than other data collection methods. The questionnaire was constructed carefully, using questions that covered all aspects of the study (Verma & Mallick, 2004).

The Likert scale was used for evaluation purposes because it allows participants to indicate their level of agreement or acceptance of a particular opinion. The Likert scale is widely used in social and educational research and aims to measure the views of the participants (Robson, 2007).

The questionnaire used in this research was divided into different sections based on the content of the questions. Specifically, the first page of the questionnaire provided an introductory paragraph containing information about the research purposes and the confidentiality of the responses. The first part of the questionnaire collected demographic information from the respondents, such as gender, age, educational level, etc. The second part of the questionnaire included the research questions. For this research, a random convenience sampling method was used (Cohen & Manion, 1994).

The distribution and collection of the questionnaires were conducted electronically. The questionnaire was created in an electronic form (Google Forms) and then sent via email to the Secondary Education Directorates throughout Greece, which then forwarded them to schools in each region. Additionally, the questionnaires were distributed through communication with specific Environmental Education Directorates and certain schools with which the researcher had served or maintained personal contact. Furthermore, the research was disseminated through social media platforms. The choice of online completion of the questionnaires (electronic survey) was made to reduce the economic cost and time required for conducting the research and to ensure anonymity (Olsen, 2009; Van Selm & Jankowski, 2006).

To ensure reliability, Cronbach's alpha coefficient was computed for the Likert-type questions. The coefficient value was found to be .805 (for an 18-item scale), exceeding the threshold of 0.70, which is considered necessary (Bernstein & Nunnally, 1994).

Table 1: Research questions and questions of the questionnaire used

Research Question 1: What are the views of secondary school teachers on the level of their ability to implement educational topics on waste management?	Q.16 To what extent do you consider yourself capable of implementing: (EEP = Environmental Education Programme)* (Not at all, A little, A little, Moderately, Quite a lot, A lot) a. EEP related to solid waste management b. EEP related to wastewater management c. Teaching a course related to solid waste management d. Teaching a course related to wastewater management
Research Question 2: What are the views of secondary school teachers on their willingness to implement or organise Environmental Programmes on waste management?	Q.17 Would you like to participate in the implementation of an Environmental Programme related to solid waste management? Q.18 Would you like to organise an Environmental Programme related to solid waste management?

	Q. 19 Would you like to participate in the implementation of an Environmental Programme related to the wastewater management? Q.20 Would you like to organise an Environmental Programme related to wastewater management?
Research Question 3: What is the level of knowledge related to waste management?	Q.21 Here is a list of terms related to waste management. Choose one of the answers. (I have never heard of it, I have heard of it but don't know what it means or I have heard of it before and know what it means) a. Paper Recycling b. Composting c. Waste Harvesting System d. Sanitary Landfills e. Sanitary Residuals Landfills f. Waste g. Garbage h. Municipal Solid Waste i. Inert waste j. Wastewater k. Sewage l. Biological wastewater treatment m. Wastewater Treatment Plants (WWTPs) Q. 22 Please indicate how much you agree or disagree with the following statements: a. A particular material becomes waste only when its owner declares it as such b. Incineration in incinerators should be implemented as an alternative to landfill, as it leads to a reduction in the amount of waste while releasing energy that can be used. c. Landfilling of waste is an integral part of the overall waste management process. d. The incineration of waste in incinerators involves the waste of materials that could be reused through recycling e. Rainwater must be discharged into the central sewerage system f. Industrial wastewater should be treated before it enters the central sewerage system Q. 23 Please rank the importance of the following options in waste management (1 most important, 4 least important)* i) Recycling/Composting ii) Reuse of waste iii) Recovery or production of energy from waste iv) Minimizing the amount of waste generated

The research sample consisted of active secondary education teachers from all disciplines. The sample size was 332 individuals. In terms of gender distribution, it was found that the percentage of female respondents was higher (64.8%) compared to male respondents (35.2%).

The data collected in this research were processed and analyzed using the statistical analysis software SPSS version 28. A range of appropriate analyses and checks were performed to draw reliable conclusions. A descriptive analysis of the data was conducted, including frequency analysis, means, and standard deviations.

4. Results and Discussion

Regarding the age of the sample, the majority belonged to the age group of 46-55 years (34.3%). The majority were general education teachers (77.1%). It is noticeable that most of the sample held a postgraduate degree (56.0%).

In terms of years of teaching experience, the sample included 215 teachers with more than 10 years of experience (64.8%), 49 teachers with 5-10 years of experience (14.8%), 47 teachers with 2-4 years of experience (14.2%), and 21 teachers with less than 1 year of experience (6.3%). Permanent teachers accounted for the majority with a percentage of 76.8%, followed by substitute teachers at 22%.

The research included educators from 41 different specialties, with the most popular being philologists, mathematicians, and computer science teachers. Most of the sample served in general lower secondary schools (34.9%) and general upper secondary schools (23.2%).

The educators serving in urban areas constituted the majority with a percentage of 72%, followed by those serving in semi-urban areas with 14.5%.

Regarding the specialization of the sample in Environmental Education, 68.4% reported not having any specialization or receiving any kind of training. Only 24.7% stated that they had received some form of training or education in waste management.

Finally, it was found that 56.6% of the educators reported having participated in the implementation of an Environmental Program in the past, but only 14.2% had participated in an Environmental Program related to waste management.

4.1 Teachers' views on the level of their ability to implement educational topics on waste management

According to the results of the conducted research, secondary education teachers' views regarding their ability to implement educational subjects (EEP or course) related to waste management show high values in standard deviation (ranging from 1.24 to 1.3 respectively) in all categories of educational subjects.

Table 1: Mean and standard deviation of teachers' views on their level of ability to implement educational issues related to Waste Management

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Implementing a EEP related to solid waste management	332	1	5	2,83	1,260
Implementing a EEP related to wastewater management	332	1	5	2,64	1,242
Teaching a course related to solid waste management	332	1	5	2,71	1,298
Teaching of a course related to wastewater management	332	1	5	2,62	1,280
Valid N (listwise)	332				

This indicates that the views reported by secondary education teachers in Greece about their ability to implement educational activities related to waste management are distributed across a wide range of values.

The mean scores (ranging from 2.62 to 2.83 respectively) reveal that teachers declare a moderate to low level of ability to conduct educational activities on topics related to waste management. From the comparison of the mean scores, it appears that teachers feel more confident implementing Environmental Education Programs (EEP) related to solid waste management and less confident teaching courses related to wastewater management.

4.2 Teachers' views on their willingness to implement or organize Environmental Programmes on waste management

The views of secondary education teachers regarding their willingness to participate in Environmental Education Programs (EEP) related to waste management show that teachers demonstrate interest in participating in and organizing environmental programs related to waste management, in general. However, there is a slight preference in participating rather than organizing such programs, as well as a preference for solid waste management compared to wastewater management.

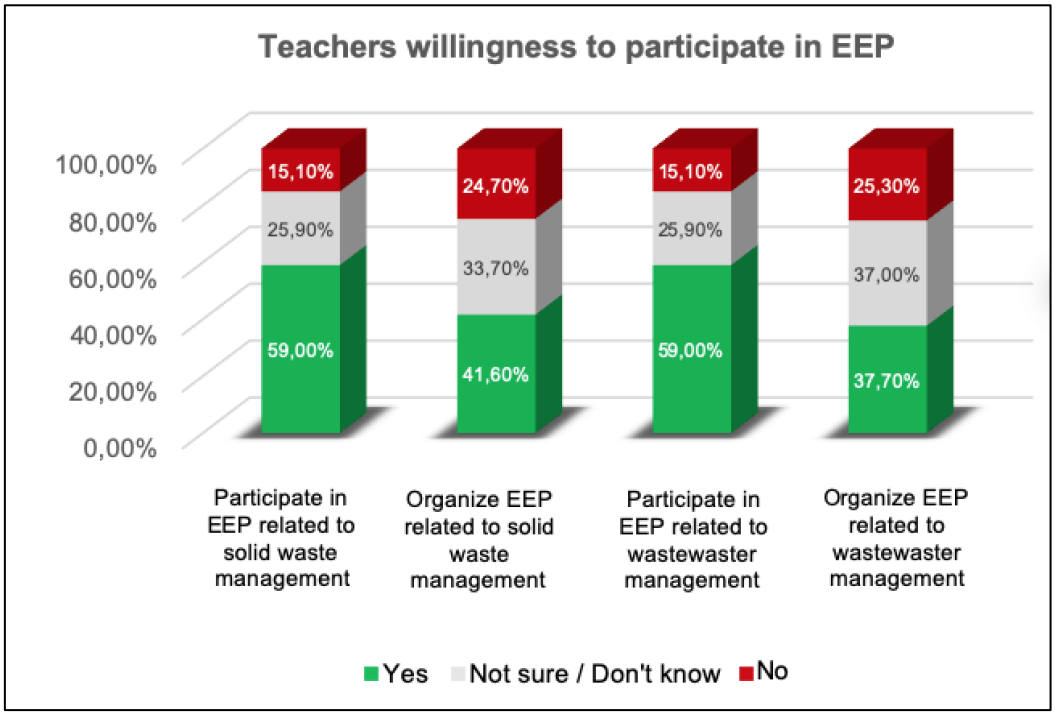

Figure 1: Allocation of teachers' implementation of EEP related to WM

4.3 Teachers' level of knowledge related to waste management

Regarding the knowledge of terms related to Waste Management that the teachers report, it seems that the majority are familiar with most of the terms, as the percentage of those who claim to know the meaning of the terms exceeds 50% in each case. Additionally, some terms such as "Paper Recycling," "Composting," and "Biological Treatment" are particularly well-known, with knowledge rates exceeding 90%. However, there are certain terms, such as "Inert Waste" and "Wastewater Treatment Plants," that teachers have less knowledge of, with percentages below 60%.

Table 2: Teachers' statements on knowledge of terminology related to Waste Management

		N	%
Paper Recycling	I've heard it, but I don't know what it means	4	1,20%
	I've heard it before and I know what it means	328	98,80%
Composting	I've never heard of it	2	0.6%
	I've heard it, but I don't know what it means	20	6.0%
	I've heard it before and I know what it means	310	93.4%
Waste Harvesting System	I've never heard of it	12	3,60%
	I've heard it, but I don't know what it means	70	21,10%
	I've heard it before and I know what it means	250	75,30%
Sanitary Landfills	I've never heard of it	3	0.9%
	I've heard it, but I don't know what it means	34	10.2%
	I've heard it before and I know what it means	295	88.9%
Sanitary Residuals Landfills	I've never heard of it	52	15.7%
	I've heard it, but I don't know what it means	111	33.4%
	I've heard it before and I know what it means	169	50.9%

Waste	I've never heard of it	3	0,90%
	I've heard it, but I don't know what it means	40	12,00%
	I've heard it before and I know what it means	289	87,00%
Garbage	I've never heard of it	1	0,30%
	I've heard it, but I don't know what it means	22	6,60%
	I've heard it before and I know what it means	309	93,10%
Municipal Solid Waste	I've never heard of it	23	6,90%
	I've heard it, but I don't know what it means	88	26,50%
	I've heard it before and I know what it means	221	66,60%
Inert Waste	I've never heard of it	80	24,10%
	I've heard it, but I don't know what it means	127	38,30%
	I've heard it before and I know what it means	125	37,70%
Wastewater	I've never heard of it	21	6.3%
	I've heard it, but I don't know what it means	89	26.8%
	I've heard it before and I know what it means	222	66.9%
Sewage	I've never heard of it	7	2,10%
	I've heard it, but I don't know what it means	51	15,40%
	I've heard it before and I know what it means	274	82,50%
Biological Wastewater Treatment	I've never heard of it	2	0,60%
	I've heard it, but I don't know what it means	36	10,80%
	I've heard it before and I know what it means	294	88,60%
Wastewater Treatment Plants (WWTPs)	I've never heard of it	47	14,20%
	I've heard it, but I don't know what it means	107	32,20%
	I've heard it before and I know what it means	178	53,60%

From the responses of teachers to knowledge-related questions about Waste Management, it occurs that teachers have a moderate level of basic knowledge. However, the standard deviation (ranging from 1.063 to 1.279 respectively) indicates that their knowledge is distributed across a wide range, reflecting the variability of knowledge among teachers. Furthermore, the mean scores (ranging from 2.30 to 4.27 respectively) reveal significant differences in knowledge levels across different questions, with teachers demonstrating inadequate knowledge in two of the questions, moderate knowledge in three, and high knowledge in only one question. Teachers answered the knowledge questions correctly with a percentage of 56.09%, with only three teachers answering correctly in all the questions. The results of the familiarization of secondary education teachers on terms related to waste management are similar to the results of secondary education students in Greece (Karachalios et al., 2021).

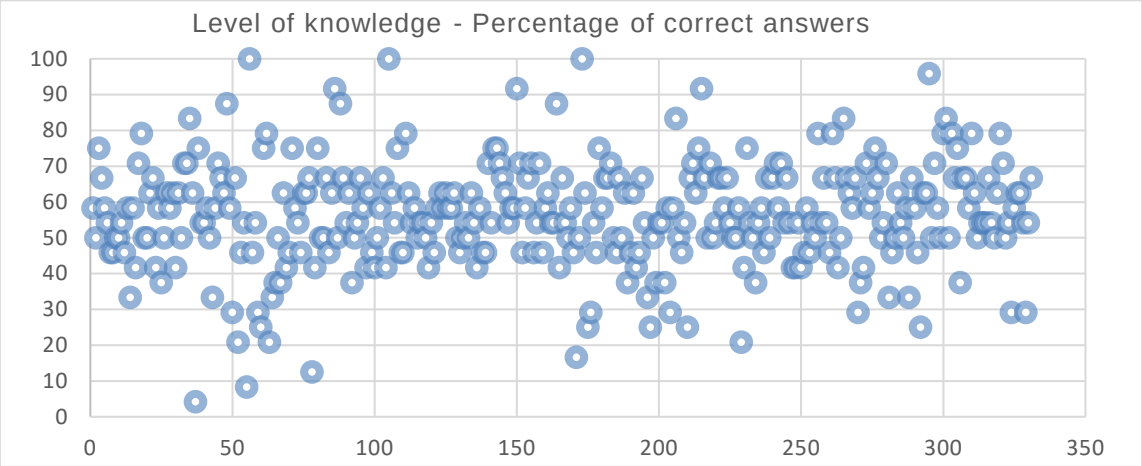

Figure 2: Percentages of teachers' correct answers
to knowledge questions on waste management

The teachers responded also, about the importance of waste management actions and were asked to prioritize them. According to the results, most teachers (88.9%) failed to correctly rank the priorities. Only 11.1% of the teachers answered correctly, placing waste minimization as the priority, followed by reuse, recycling/composting, and finally recovery or energy production from waste. It is worth noting that only 45.5% of the teachers chose waste minimization as the most important action, while a significant percentage of 39.2% chose recycling as the most important action. These results indicate that the understanding of the basic principles of waste management hierarchy is limited among teachers and highlights the need for further education and awareness in this area.

In conclusion, most secondary education teachers in Greece, state that they have a satisfactory level of knowledge regarding waste management. However, the effectiveness of this knowledge is moderate, as indicated by their responses. Teachers have a moderate level of basic knowledge but demonstrate a limited understanding of waste management principles. Additionally, most teachers were not able to correctly prioritize waste management actions, raising concerns about the adequacy of education and information on this topic.

When comparing the research data with other studies held on secondary education teachers in Greece (Daskolia, 2005; Zisi, 2021), some similarities can be observed. Both sets of data indicate a need for further education and training of educators in environmental education. They also highlight the positive attitudes of educators towards implementing environmental actions and the importance of addressing environmental issues in schools.

5. Recommendations

Based on the presented data, it can be inferred that there is a need for further education and training of teachers in practical waste management practices. While most teachers reported familiarity with waste management terminology, the comprehension and

effective application of this knowledge is lacking. Moreover, the fact that most teachers were not able to correctly rank the strategies of waste management highlights the need for more comprehensive education and training on the subject.

Given these research findings, several recommendations can be made to enhance waste management education and environmental sustainability in secondary education. Firstly, it is crucial to provide practical and comprehensive training programs for teachers that address specific knowledge gaps and incorporate practical applications of environmental education. Offering resources and support mechanisms can facilitate the integration of environmental education into lessons (Cini & Mifsud, 2018; Kougias, Sardianou, & Saiti, 2022; Gomatos et al., 2018).

Secondly, enriching the curriculum with elements of sustainability and waste management is essential to eliminate misconceptions and promote sustainable behaviors. Promoting multidisciplinary approaches to sustainability issues and ensuring that sustainability education is not peripheral, but a central component of the curriculum is also vital (Kougias et al., 2022).

Furthermore, raising awareness among teachers about the importance of environmental education and waste management is necessary. Fostering positive environmental attitudes and motivating teachers to actively engage in promoting sustainability in their classrooms are crucial aspects (Debrah, Vidal, & Dinis, 2021).

Collaboration among teachers, schools, environmental organizations, and local communities can contribute to developing comprehensive waste management initiatives. Providing necessary resources such as high-quality educational materials and platforms aligned with curriculum objectives is also recommended (Kougias et al., 2022).

By implementing these recommendations, secondary education can effectively promote waste management practices, enhance environmental knowledge and attitudes, and contribute to sustainable development goals. Empowering teachers and providing them with the necessary support and resources is crucial in creating environmentally conscious students who actively participate in waste reduction and environmental protection efforts (Cini & Mifsud, 2018; Debrah et al., 2021; Kougias et al., 2022).

6. Conclusion

The research findings highlight the need for improvement in environmental education and waste management practices in Greek secondary education. While teachers demonstrate positive attitudes towards environmental actions and the importance of addressing environmental issues, there are gaps in their knowledge and understanding of waste management concepts.

Most of the teachers, report having a satisfactory level of knowledge regarding waste management. However, their effectiveness in applying this knowledge is moderate, as indicated by their responses. Teachers demonstrate a moderate level of basic

knowledge but have a limited understanding of waste management principles, as evidenced by their incorrect prioritization of waste management actions.

The findings emphasize the importance of providing comprehensive professional development programs for teachers, integrating waste management topics into the curriculum, and fostering collaborative approaches among schools, environmental organizations, and communities. Specialization, training opportunities and development of high-quality educational resources, can further support teachers in delivering effective waste management education.

By implementing the recommendations provided, Greek secondary education can enhance environmental education efforts, promote sustainable waste management practices, and empower students to become environmentally conscious citizens. Continuous evaluation and monitoring will be essential to ensure these initiatives' effectiveness and long-term impact.

The restrictions of this research include its limited scope in terms of geography and sample size. Future studies are advised to replicate this investigation in other contexts and across a larger sample size for a more robust understanding of the issues at hand. Furthermore, this study also predominantly relied on teachers' self-reported data, which may encompass a degree of subjectivity. Future research should adopt mixed methods approaches to counter this potential bias and provide a more accurate reflection of teachers' knowledge and views. For instance, qualitative data collection tools such as in-depth interviews, focus group discussions, and direct classroom observations can offer richer, more nuanced insights into teachers' environmental education and waste management practices.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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