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High school chemistry teachers' attitudes toward incorporating environmental education topics into the chemistry curriculum in Israel

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Abstract: This study examined chemistry teachers' attitudes toward incorporating environmental education into high-school instruction and its potential to strengthen scientific literacy and sustainability awareness. It aimed to characterize teachers' attitudes toward addressing environmental issues, identify environmental education topics perceived as suitable for the chemistry curriculum, and explore how seniority and graduate education relate to willingness to teach this content. Semi-structured interviews with 33 Israeli Arabic-sector high-school chemistry teachers were conducted. Despite broad acknowledgment of the importance and relevance of environmental education, integration into chemistry was found to be curtailed by the rigid curriculum, instruction time, and the pressure of standardized assessment. The teachers reported greater readiness to address topics with explicit chemical grounding such as air and water pollution, atmospheric chemistry, and global warming, but more hesitancy toward interdisciplinary themes such as biodiversity and consumption patterns. Willingness was higher among teachers with greater seniority, master's degrees, and men. These findings help delineate the prerequisite conditions for embedding environmental education within subject-specific chemistry curricula and can inform the design of supportive policies and teacher learning. Recommendations include curricular adjustments, targeted professional development, and pedagogical guidance.

Keywords: chemistry curriculum; environmental education; high school science teaching; teachers' attitudes; ECRICE 2024

1 Introduction

Education serves as a fundamental mechanism for nurturing environmental awareness and cultivating a culture of sustainable development.[1] Environmental education plays a critical role in addressing technological advances, consumerism, and urbanization when they threaten ecological stability and human survival.[2] Environmental education extends beyond the simple delivery of knowledge but rather is vital to shaping environmental values, fostering deeper understanding, and developing the essential skills for responsible environmental behavior.[3]

The final report of the Intergovernmental Conference on Environmental Education defined environmental education as a means to empower individuals of all ages and backgrounds to internalize values and acquire

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practical knowledge. The goal is to enable students to recognize environmental problems and contribute to environmental preservation.[4,5]

Environmental education has evolved from the traditional belief that knowledge alone leads to action[6] to emphasizing the complex interplay of cognitive, social, and behavioral factors that influence environmental responsibility. To cultivate a sense of environmental stewardship, students need to develop a comprehensive understanding of ecosystems, critically analyze environmental challenges, and acquire problem-solving skills to address them effectively.[7] The declining awareness of human impact on the environment has become a growing concern,[8] underscoring the need for environmental education.[9] Lubomira[10] pointed to environmental education as a key instrument for transforming attitudes and ensuring a sustainable future. The literature on environmental education, as well as broader international policy frameworks, particularly target 4.7 of the UN Agenda 2030 include the goal that by 2030 all learners should acquire the knowledge, skills, values, and attitudes to promote sustainable development.[6,11] Teachers' perceptions and attitudes can serve as key mediating factors: they determine whether curricular intentions are effectively translated into classroom practices.[12] However, there is scant research on teachers' attitudes toward incorporating environmental topics into chemistry teaching, despite the fact that these attitudes constitute the preconditions for the meaningful integration of environmental education into the chemistry curriculum.

As a scientific discipline, chemistry holds immense potential for advancing sustainability. Jegstad and Sinnes[13] argued that chemistry education should empower students to analyze chemical processes and assess their environmental and societal implications. To make chemistry more relevant and engaging, instruction should integrate real-world issues such as pollution, renewable energy, and water quality. Incorporating environmental education into chemistry curricula can also encourage students to explore controversial topics such as the use of plastics, energy production, and pollution in terms of their ethical, scientific, and social impact. By adopting green chemistry principles that emphasize safer products and processes, students can connect core chemical concepts with sustainability initiatives including waste reduction and the development of environmentally friendly materials.[14]

Despite the recognized importance of environmental education, it remains underrepresented in school curricula worldwide.[15] Icoz[16] noted that the essential topics for environmental education are pollution, global warming, biogeochemical cycles, energy use, and environmental solutions such as recycling and renewable energy. To instill values and foster environmental responsibility, environmental education should be deeply embedded in school curricula rather than be treated as an optional supplement.[17] Hands-on, context-based activities are particularly effective in increasing student engagement and deepening students' understanding of environmental concepts.[18]

The integration of green and sustainable chemistry into education requires a broader shift toward Education for Sustainable Development, which necessitates substantial reforms in curriculum design and the development of educational materials. It also requires enhanced teacher training to incorporate scientific, social, ethical, and environmental perspectives into chemistry education.[16]

While some studies have advocated for a separate environmental education curriculum, others have argued for its integration within broader science instruction. In addition, education must extend beyond classroom walls, by fostering community engagement and building environmental literacy.[19] Although environmental and sustainability education are acknowledged in policy documents, they remain non-mandatory and largely dependent on individual teachers' commitment. To enhance their impact, teachers must be empowered as "street-level policy entrepreneurs," who are capable of shaping educational practices and promoting sustainability initiatives within schools and communities. Ultimately, environmental and sustainability education serves not only as a tool for teaching about environmental issues but also as a mechanism for broader social transformation. It positions educators at the forefront of integrating sustainability values into education and society.[20]

Chemistry teachers, in particular, can act as "gatekeepers" of curricular content by deciding which environmental topics are emphasized and how they are framed to students.[13] This requires structural reforms and increased teacher support to ensure that chemistry education contributes meaningfully to sustainability.[21] By linking chemistry education to pressing environmental challenges, students gain a deeper understanding of

science while developing a strong commitment to sustainable practices. Environmental education is often regarded as a prerequisite stage for Education for Sustainable Development (ESD), as it provides the foundational knowledge, values, and attitudes upon which broader sustainability competencies can be built.[12] Thus examining chemistry teachers' attitudes toward incorporating environmental education constitutes an essential first step toward advancing more comprehensive approaches to sustainability education.

1.1 Main topics in environmental education in chemistry

As a fundamental scientific discipline, chemistry underpins numerous fields including biology, medicine, biotechnology, and materials science.[22] Given its interdisciplinary nature, chemistry education provides an ideal platform for integrating environmental education. Research indicates that teaching chemistry within real-world contexts improves students' academic performance and increases their interest in the subject.[23] For example, incorporating a unit on bioplastics in chemistry courses was shown to enhance pre-service teachers' awareness and positive attitudes toward sustainability and environmental education.[24]

Osunji[25] underscored the synergy between chemistry and environmental education, and advocated for curriculum updates that reflect contemporary environmental challenges. By bridging chemistry with sustainability, educators can equip students with the knowledge and skills needed to contribute to a more sustainable future.

1.2 The Israeli high school chemistry curriculum

In Israel, although both in-service and pre-service teachers generally have positive attitudes toward environmental education, their knowledge of sustainability and green chemistry is often rudimentary.[11] Environmental education is not a standalone, and is incorporated into subjects such as chemistry, physics, and biology. The urgency of strengthening environmental and sustainability education in Israel is underscored by rapid population growth, consumerism, and the complexity of its multicultural society. The Israeli high school chemistry curriculum consists of a core component (70 %) covering essential topics and a specialization component (30 %) offering electives such as environmental chemistry.[22] Thus environmental themes are largely absent from the mandatory content. Since environmental chemistry is optional, few students engage with these critical issues.

1.3 The current study

Studies have emphasized the need for reforms that support teachers in incorporating environmental education into chemistry lessons.[21,26,27] This study investigated Israeli chemistry teachers' views on incorporating environmental education into their instruction and the curriculum topics that should be prioritized to foster students' environmental awareness and responsibility. Specifically, it examined:

(1) What are chemistry teachers' attitudes toward incorporating environmental education topics into chemistry teaching, and how do they view the potential for such integration?
(2) Which environmental topics do chemistry teachers feel are the most relevant and should be incorporated into the chemistry curriculum?
(3) Which topics in chemistry do teachers feel can best be incorporated into environmental education, and what rationales do teachers provide?
(4) How are teachers' seniority and level of graduate education associated with (a) their attitudes toward incorporating environmental education topics and (b), where applicable, their self-reported extent of classroom incorporation?

2 Methods

In this qualitative case study, semi-structured interviews were conducted with high school chemistry teachers to explore their attitudes towards the incorporation of environmental education into the chemistry curriculum in Israel. Thematic content analysis was used to process the data via an inductive approach. Validity and reliability were ensured through member checking, expert review, and cross-validation with the official curriculum.

2.1 Participants

The sample was composed of 33 experienced high school chemistry teachers, who prepare students for the matriculation exam (the maximum of 5 points) in the Arabic-speaking school system in Israel. Of the sample, 15 participants were male and 18 were female. 13 had a bachelor's degree, and 20 had a master's degree. Five teachers had fewer than 5 years of experience, 10 had between 6 and 15 years, and 18 had more than 15 years of teaching experience.

Teachers involved in preparation for the matriculation exam were chosen because these teachers have an in-depth understanding of the content, objectives, required skills, and pedagogical principles of the chemistry curriculum. All the participants had earned their degrees at Israeli universities and were certified to teach chemistry at the high school level. In the findings, all teacher names are pseudonyms.

2.2 Research instrument

Semi-structured interviews with open-ended questions were conducted to examine the chemistry teachers' attitudes toward the incorporation of environmental education into the chemistry curriculum. This format allows for flexibility in guiding the conversation through follow-up questions, thus enabling participants to provide detailed and comprehensive responses.

The interviews, conducted face-to-face at the participants' schools, lasted approximately 50 min each and were audio-recorded and transcribed verbatim. To develop the semi-structured interview guidelines, a literature review was conducted. An eight-question protocol was developed[12,16] and revised through a pilot interview with two experienced chemistry teachers to confirm that the questions were understood and aligned with the study's aims. Sample questions include:

(1) To what extent do you think the current chemistry curriculum allows for, or relates to, the incorporation of environmental education?
(2) Which topics or subjects in the chemistry curriculum, in your opinion, could include elements or aspects of environmental education?
(3) How do you view the possibility of addressing and incorporating environmental education topics into your chemistry lessons?
(4) As a chemistry teacher, to what extent do you emphasize environmental education topics in your teaching, and why (or why not)?

2.3 Data collection and analysis

The transcripts first underwent systematic content analysis by three of the authors, two of whom have a pH.D. in chemistry, to identify key themes and patterns. The data categorization was iterative, and involved cycles to refine the emerging themes for accuracy. To enhance the credibility and reliability of the findings, member checking was conducted, where participants reviewed and confirmed the accuracy of interview transcripts and summaries. An expert in science education reviewed the thematic analysis and findings to ensure methodological rigor. The teachers' statements were cross-checked against the official chemistry curriculum to validate the consistency between their perceptions and actual curriculum content.

3 Findings

3.1 Chemistry teachers' attitudes towards incorporating environmental education into chemistry instruction

Although all the chemistry teachers acknowledged the strong connection between chemistry and environmental education, particularly in the matriculation curriculum, they indicated that environmental education is not meaningfully incorporated in the classroom. In particular, the curriculum does not include explicit references to environmental principles, which the teachers viewed as essential for scientific literacy, responsible citizenship, and preparing students for contemporary environmental challenges.

The current matriculation chemistry curriculum consists of compulsory core subjects and elective extension units. Environmental education is mostly confined to the elective *"Environmental Chemistry"* unit, which not all students take. Many teachers prioritize core material to ensure exam success, and often choose elective topics that are better aligned with this goal. Even within the environmental chemistry elective, the teachers felt that the curriculum pays insufficient attention to key concepts such as human impact, environmental justice, and ecological footprint.

The analysis revealed a gender-based difference in teachers' willingness to incorporate environmental education. Of the 18 female teachers, only 6 expressed willingness to include environmental topics, and indicated they would incorporate 7 out of the 11 suggested topics. By contrast, 11 of the 15 male teachers were willing to incorporate 10 of the 11 environmental topics.

The male teachers reported that they often went beyond the official curriculum, and justified their approach by stressing the urgency of issues such as pollution, resource depletion, climate change, and health risks. They viewed environmental education as inseparable from chemistry, given its major role in civic responsibility and ethics. Several emphasized teacher initiatives, and noted that students should be equipped with problem-solving skills to address real-world environmental challenges. The female teachers, while acknowledging the importance of environmental education, tended to adhere more closely to the curriculum. They cited time limitations and exam preparation as reasons for focusing on the core chemistry content. Their primary concern was ensuring that students master the essential concepts required for matriculation exam success.

3.2 Chemistry topics identified by teachers as relevant to environmental education

To assess which environmental subjects should be incorporated into the chemistry curriculum for the matriculation examination, the teachers were presented with a list of 11 environmental topics outlined by the Israel Ministry of Education[22]. They were asked to state whether each topic could be incorporated into chemistry instruction. As shown in Table 1, there were significant differences in teachers' views on the incorporation of environmental topics into the chemistry curriculum.

Most teachers agreed that topics directly related to chemistry such as global warming (79 %), air pollution (73 %), water pollution (67 %), energy (70 %), and population and environment (67 %) could be included, but that topics like biodiversity (18 %) and consumption patterns (15 %) were less relevant to core chemistry content.

Hend explained: "*I don't have time to cover environmental topics instead of core chemistry concepts*". Another teacher added: "*Biodiversity and consumption patterns require extra effort to connect to chemistry, so we should prioritize topics with a clear chemical foundation*". Alia advocated for incorporating all environmental issues, arguing: "*Environmental challenges are both directly and indirectly linked to chemistry. Teachers should foster environmental literacy*". She emphasized the urgency of interdisciplinary teaching: "*Human activity has led to an environmental crisis. Climate change is a major threat, and education must be part of the solution. The curriculum should reflect this reality and offer scientific responses*".

Table 1: Teachers' responses (*N*=33) on the incorporation of environmental education topics into chemistry.

	Environmental education topics	The topic can be incorporated into chemistry	The topic cannot be incorporated into chemistry
		***N* (%)**	***N* (%)**
1	Water pollution	22 (67 %)	11 (33 %)
2	Solid waste	17 (52 %)	16 (48 %)
3	Hazardous waste	15 (45 %)	18 (55 %)
4	Global warming	26 (79 %)	7 (21 %)
5	Air pollution	24 (73 %)	9 (27 %)
6	Biodiversity	6 (18 %)	27 (72 %)
7	Consumption patterns	5 (15 %)	28 (85 %)
8	Noise pollution	17 (52 %)	16 (48 %)
9	Population and environment	22 (67 %)	11 (33 %)
10	Environmental recycling	13 (39 %)	20 (61 %)
11	Energy	23 (70 %)	10 (30 %)

3.3 Chemistry areas identified by teachers for the effective incorporation of environmental education

To determine the most appropriate incorporation of environmental education topics within the chemistry curriculum, the teachers were asked to identify which chemistry topics could effectively incorporate environmental issues. The findings, as summarized in Table 2, revealed varying degrees of agreement regarding the incorporation of environmental topics within specific areas of chemistry.

The teachers mostly agreed that topics such as global warming, air pollution, water pollution, energy, and solid waste could be incorporated into chemistry instruction. They felt that these connections could be made while teaching industrial chemistry, organic chemistry, gases, acids and bases, and environmental chemistry. However, biodiversity and consumption patterns were largely rejected as suitable for chemistry teaching, because many teachers perceived them as more relevant to other disciplines like biology or social studies.

Alia linked global warming to organic chemistry: "*In combustion reactions, carbon dioxide emissions must be examined, because they are directly connected to global warming*", whereas Rami associated global warming with gas properties, explaining: "*When teaching states of matter, I discuss greenhouse gases and their impact on climate change*".

Rania linked water pollution to industrial chemistry and argued that "*Industry is the main source of pollutants, making air and water pollution crucial in industrial chemistry*". Ahmed linked it to compounds and solutions, arguing: "*Water, as a solvent with dissolved substances, makes contamination relevant to solutions*". Hassan associated it with acids and bases, stating: "*Factory pollution often contains acidic substances, directly linking it to this topic*".

Solid waste was mainly connected to industrial chemistry, due to its industrial origins. However, Louis suggested including it in the unit on environmental chemistry, emphasizing: "*Environmental chemistry covers pollution, and waste is a major contributor*". Others linked it to chemical compounds, particularly polymers and organic chemistry, and took a materials science perspective. Unlike other topics, all the teachers concurred that energy and noise pollution needed to be integrated into classroom teaching and suggested it fit best with the "Energy and Dynamics" unit due to its relevance to core chemistry. Similarly, noise pollution was consistently placed in industrial chemistry, since "*factories are major sources of noise pollution*". By contrast, most teachers felt that biodiversity and consumption patterns were more relevant to biology, economics, or the social sciences.

Table 2: Teachers' responses (%) on the incorporation of environmental education topics into specific units in the chemistry curriculum.

		Environmental education topics										
		Water pollution	**Solid waste**	**Hazardous waste**	**Global warming**	**Air pollution**	**Biodiversity**	**Consumption patterns**	**Noise pollution**	**Population and environment**	**Environmental recycling**	**Energy**
Chemistry education topics	Industrial chemistry	18	15	27	12	15	12		55	6		
	Chemical compounds	15									25	
	Structure and bonding	12									15	
	Solutions	30										
	Organic chemistry		9		9							
	Environmental chemistry		15			24				46	30	
	Polymers		21			31						
	Gases			12	58							
	Energy			12	12							49
	Acids and bases					15						
	Food chemistry							9		24		10
	This topic cannot be included in chemistry	25	40	49	9	15	88	91	45	24	30	41
Total (%)		100	100	100	100	100	100	100	100	100	100	100

3.4 The influence of teachers' seniority and graduate degree on the incorporation of environmental education in chemistry instruction

Teaching experience was correlated with willingness to incorporate environmental education into chemistry instruction. In comparison to less experienced teachers, teachers with over 15 years of experience showed a stronger commitment to incorporating environmental topics despite the curriculum's limited emphasis. Teachers with more experience also demonstrated greater environmental awareness, a deeper understanding of environmental education's role in addressing global challenges, and broader knowledge of the chemistry curriculum. This enabled them to identify relevant environmental topics and incorporate them effectively into chemistry classes. They also exhibited more confidence in making interdisciplinary connections.

Table 3: The relationship between teaching experience (seniority) and willingness to incorporate environmental education (*N*=33).

Teaching experience	Number of teachers willing to incorporate environmental education topics	The average number of environmental topics (out of 11) they were willing to incorporate
Fewer than 5 years (*N*=5)	2	5
6–15 years (*N*=10)	5	7
More than 15 years (*N*=18)	15	10

Hassan, with over 20 years of experience, provided detailed responses and real-world examples to support his approach. He stated: "*I devote part of my chemistry lessons to discussing environmental issues. This enriches learning and fosters responsible, informed individuals. Students are naturally interested in real-world issues, and linking science to society increases their engagement. How can I teach industrial chemistry without addressing air pollution in the Haifa Bay and its health impact? Chemistry is deeply connected to environmental issues, and students need this broader perspective*".

As shown in Table 4, teachers with a master's degree were more willing to incorporate environmental education into chemistry instruction than those with a bachelor's degree. These teachers demonstrated greater awareness of the importance of environmental topics in chemistry and actively proposed ways to incorporate them into lessons.

Table 4: Relationship between graduate degree and willingness to include environmental education topics in chemistry (*N*=33).

Teachers' graduate degree	Number of teachers willing to incorporate environmental education topics	The average number of environmental topics (out of 11) that they were willing to incorporate
M.Sc. (*N*=20)	13	11
B.Sc. (*N*=13)	6	7

Rafa highlighted the strong connection between chemistry and environmental issues, stating: "*Chemistry and environmental topics are tightly linked. Teaching environmental issues in chemistry enhances students' understanding, promotes awareness, and fosters responsible behavior*". Similarly, Abir linked the curriculum to environmental education. She provided lesson examples and advocated for a constructivist, spiral approach: "*Environmental education should go beyond learning facts. Students need to understand solutions and develop the ability to drive change. Effective teaching guides them in forming informed opinions and making responsible decisions. This depends on the teacher's awareness and commitment*".

4 Discussion

Research has consistently highlighted the crucial role teachers play in fostering environmental literacy by incorporating environmental education into their classroom practices.[28] Teachers serve as key agents in curriculum development and implementation by influencing how educational reforms translate into classroom instruction.[29] The findings revealed that although the chemistry teachers were cognizant of the strong links between chemistry and environmental issues, they all indicated that environmental education is only marginally incorporated into the curriculum. This disparity between theory and practice underscores a more general challenge in science education, where environmental topics are acknowledged as important but remain peripheral without explicit curricular guidance.[19,21]

The teachers reported that while chemistry naturally covers issues such as pollution, energy, and global warming, these are mostly confined in the curriculum to electives such as Environmental Chemistry, which many students are never exposed to. The absence of explicit curricular guidance reduces opportunities to link chemistry with real-life challenges, thus diminishing students' engagement and understanding of sustainability.[30] Teachers are further constrained by the pressure of the matriculation exams, which discourages them from deviating from the prescribed syllabus.[11] A lack of continuing education programs for teachers and practical resources such as labs also hinders effective integration,[31] leaving efforts inconsistent and highly dependent on individual initiatives. The observed preference for topics with an explicit chemical anchor – and the hesitancy toward interdisciplinary themes – suggests that the data captured teachers' attitudes and decision logics, not a comprehensive enactment of environmental education. In other words, teachers' perceptions functioned as a prerequisite layer that shaped whether and how environmental education might later be embedded within chemistry instruction.

Clearly, chemistry is fundamentally linked to real-life environmental problems, and green chemistry principles offer essential approaches for addressing these challenges.[14,30] Therefore, ignoring broader environmental topics prevents students from understanding the connections between chemical processes and their societal and ecological impacts, such as pollution and resource depletion. The teachers' focus on "chemically explicit" topics also reflected curricular constraints and exam pressures[11,16]. Without clear curricular guidelines, the teachers were reluctant to incorporate interdisciplinary topics, fearing they might compromise students' exam success. Nonetheless, some teachers in the study advocated for a broader approach, and emphasized that chemistry should address all environmental issues, not just those directly related to chemical reactions. This perspective supports the view that chemistry education must equip students to tackle complex sustainability challenges, including industrial pollution and material consumption.[13,32]

Previous research has shown that teachers generally have positive attitudes toward environmental education but often face practical challenges in incorporating it into subject-specific instruction.[16] Similar to the current study, some studies have found that teachers who incorporate environmental topics into chemistry do so primarily on their own initiative, since the chemistry curriculum provides little structured guidance, and that these initiatives lead to more positive attitudes toward environmental education.[24] Others have reported that when environmental education is treated as a fundamental value, teachers readily incorporated sustainability topics into their chemistry lessons even in the absence of explicit curricular directives.[17]

A gender-related pattern also emerged in how teachers approached these challenges. Male teachers were generally more proactive and willing to extend instruction to include environmental and sustainability issues, even when not mandated, in attempts to emphasize civic responsibility and interdisciplinary connections. Female teachers, while supportive of the importance of environmental education, tended to adhere more closely to the prescribed curriculum, citing exam preparation and time limitations as barriers. These results contrast with research showing that female teachers often express stronger environmental concerns and advocacy.[23,33] The current findings may suggest a gap between attitudes and classroom practice: although the female teachers valued environmental education, they may have felt less able to diverge from structured demands. Male teachers appeared more confident in managing open-ended or interdisciplinary discussions. Studies suggest that gender may influence teachers' self-efficacy and instructional abilities, particularly in areas such as problem-solving and

lesson design.[34] This may explain the differences in the way environmental topics were incorporated. Given the relatively small sample here (33 teachers: 18 females and 15 males), the observed gender differences can only provide a preliminary indication that teacher background may influence the extent and type of environmental education integration. Further studies with larger and more diverse samples are needed.

The teachers expressed varied views on the best topics to integrate into chemistry instruction, though all agreed on their general relevance. Topics such as air pollution (73 %) and global warming were widely accepted, but issues such as hazardous waste (45 %), biodiversity, and consumption patterns were perceived as less aligned with core chemistry content.[16,35] This trend reflects a preference for integrating environmental education only when it fits naturally within traditional chemistry topics – such as industrial chemistry, acids and bases, or energy – while broader or interdisciplinary themes are often excluded due to curriculum constraints and exam pressures.[21,24] Nevertheless, some teachers also described using creative integration strategies such as linking water pollution to chemical solutions or connecting solid waste to polymers, thus highlighting the potential of teaching chemistry through real-life environmental contexts.[14] However, in the absence of clear curricular support, such efforts remain inconsistent and largely reliant on individual initiative.[36]

Table 3 indicated a clear relationship between years of teaching and willingness to incorporate environmental education into chemistry lessons. Teachers with more than 15 years of experience were notably more proactive in incorporating environmental topics and took greater initiative to enhance their students' environmental understanding. These results are consistent with findings suggesting that teachers at advanced stages of professional development are more open to pedagogical innovation, motivated by continuous learning, and more receptive to curriculum changes,[37] although other studies suggest that support for environmental education may decline with increasing teaching experience[17] because experienced teachers often manifest lower self-efficacy and less enthusiasm toward change that makes them less likely to adopt student-centered approaches or collaborate on curricular innovations. Less experienced teachers may demonstrate greater confidence, enthusiasm, and willingness to embrace reform.[38] These findings highlight the need for professional development programs that are tailored to teachers' varying career stages to support their involvement in educational change. The influence of age and teaching experience on attitudes toward curricular reform may not be as strong as commonly assumed, indicating that other factors may mediate this relationship.[39]

Studies suggest that individuals with higher levels of education tend to engage more actively in pro-environmental behaviors, both in private and public contexts.[40] Table 4 showed that teachers with a master's degree demonstrated higher awareness and a stronger commitment to embedding environmental topics within their teaching than the teachers with a bachelor's degree and were also more proactive in identifying and suggesting meaningful connections between chemistry content and environmental issues. Higher educational attainment has been associated with more environmentally responsible behavior, likely due to increased exposure to sustainability-related knowledge.[41] Education also enhances individuals' sensitivity to social and environmental challenges, thereby promoting environmentally conscious attitudes.[42]

5 Recommendations

The growing emphasis on environmental education in schools has led to an increased demand for teachers who are equipped to effectively incorporate environmental topics into their instruction.[43] In the U.S., teachers have played a central role in introducing environmental education, and their attitudes have significantly influenced the extent and type of integration into classroom practice.[44] While chemistry is defined by the Israel Ministry of Education as a multidisciplinary field that connects various scientific domains,[22] the findings indicate that although the teachers broadly acknowledged the importance of environmental education, its integration into chemistry remains uneven and was often contingent on individual teacher initiative.

To address these challenges, we recommend:

(1) Curriculum reform – Incorporate environmental education into core chemistry topics, not just electives.
(2) Teacher training – Provide professional development to equip teachers with strategies for incorporating environmental topics.

(3) Clear guidelines – Develop structured guidance on seamlessly incorporating environmental education.
(4) Interdisciplinary teaching – Encourage connections between chemistry, environmental issues, and societal contexts.
(5) Balancing exam preparation – Explore ways to incorporate environmental education without compromising exam willingness.

6 Limitations

This study has several limitations. The sample size of 33 high school chemistry teachers may not represent the broader population of chemistry educators. The findings were based on semi-structured interviews which are subject to personal biases, experiences, and perceptions that may not correspond to actual classroom practices or be generalizable to other contexts. Although the teachers frequently mentioned time constraints and the rigid structure of the curriculum as obstacles to incorporating environmental education, classroom observations are needed to validate the actual impact of these constraints.

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