Journal of Environmental Health and Sustainable Development

Evaluation of the Effectiveness of the First Environmental Health Field School: A Native Model for Applied Training and Enhancement of Graduate Students' Field Skills

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A R T I C L E I N F O

ORIGINAL ARTICLE

Article History:
Received: 03 October 2025
Accepted: 20 January 2026

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Keywords:
Environmental Health Field School,
Experiential Learning,
Kirkpatrick Model.

ABSTRACT

Introduction: Classroom-based education alone is insufficient for developing practical skills in medical students. Structured field-based learning opportunities are scarce in Iran, limiting students' exposure to real-world industrial and environmental processes. This descriptive-analytical study employed an educational evaluation approach to evaluate the effectiveness of the first environmental health field school to assess its impact on participants' satisfaction, learning, behavior, and professional outcomes.

Materials and Methods: This descriptive-analytical study employed an educational evaluation approach. A researcher-made questionnaire was designed according to the four levels of the Kirkpatrick model and distributed among 19 participants

Results: The overall weighted mean of participant satisfaction at the reaction level was 4.52 out of five. At the learning level, the weighted mean was 4.19, indicating a significant improvement in practical knowledge, particularly in waste management, air pollution control, and irradiation technology. At the behavior level, the weighted mean was 3.84, reflecting the partial application of acquired knowledge in research and operational activities. Finally, at the results level, the weighted mean was 4.44, demonstrating the program's lasting impact on the participants' professional attitudes, motivation, and willingness to participate in future programs.

Conclusion: The first environmental health field school showed high effectiveness across all four levels of the Kirkpatrick model. The program significantly improved satisfaction, learning, and professional attitudes. Follow-up programs and real internship opportunities are recommended to enhance the transfer of learning into practical behavior. Expanding such field schools can strengthen students' practical skills and reinforce the university-industry links in environmental health.

Citation: Pormazar SM, Ehrampoush MH, Dalvand A. ***Evaluation of the Effectiveness of the First Environmental Health Field School: A Native Model for Applied Training and Enhancement of Graduate Students' Field Skills.*** J Environ Health Sustain Dev. 2026; 11(1): 2929-39.

Introduction

Traditional education systems in various disciplines, including environmental health engineering, are typically based on classroom and laboratory instruction, offering limited opportunities for direct experience and engagement with real-world environmental challenges. Within this framework, learning is often confined to the transmission of theoretical concepts, scientific principles, and controlled laboratory experiments, while the

[DOI: 10.18502/jehsd.v11i1.21166]

complexity of real environments and the interactions among physical, chemical, and social factors are often overlooked. Consequently, although students gain a satisfactory understanding of scientific foundations, they often lack the practical skills required to analyze and manage real situations, such as pollution control, waste management, and environmental impact assessment[1].

This classroom-based model creates a gap between theoretical knowledge and practical application, with significant consequences in applied disciplines such as environmental health. The absence of opportunities for real-world observation and analysis weakens students' ability to think critically, solve unpredictable problems, and make evidence-based decisions [2]. Moreover, this approach diminishes students' motivation, professional identity, and environmental responsibility because they fail to perceive a tangible link between academic learning and real societal challenges[3].

Studies have shown that, in the absence of field experiences, education becomes descriptive and non-interactive, leading students to memorize rather than deeply understand processes. Furthermore, such systems reduce opportunities to develop soft skills, such as teamwork, effective communication with communities, and interdisciplinary understanding of environmental issues[4]. Therefore, revising educational methods and integrating field-based learning into formal curricula is essential for training professionals capable of making informed and ethical decisions in real-world contexts[5].

With the growing complexity of environmental issues and the pressures of industrialization and urbanization, the gap between theoretical knowledge and practical skills in higher education has become increasingly evident in recent years. Traditional teaching alone no longer meets the professional and societal needs of applied fields such as Environmental Health Engineering, which require a deep understanding and direct experience of real processes [6]. In Iran, Environmental Health Engineering education is predominantly delivered through lecture-based courses and limited laboratory sessions, with relatively restricted access to structured field-based training compared to advanced educational systems in developed countries. Under such circumstances, students rarely have the opportunity to observe, analyze, and participate in field activities related to pollutant generation, water and wastewater treatment systems, industrial and municipal waste management, or air pollution control. Consequently, environmental education loses its interactive, analytical, and decision-making aspects, becoming limited to theoretical instruction and passive knowledge transfer [7].

International studies have demonstrated that participation in field-based and experiential learning programs plays a crucial role in fostering deep and lasting learning. These programs enhance conceptual knowledge, environmental literacy, interpersonal skills, and scientific self-efficacy by promoting interaction among students, real environments, and local stakeholders. They also improve academic persistence and active engagement in environmental projects[8, 9]. Moreover, research shows that field learning not only strengthens technical skills but also builds motivation, a sense of belonging to the scientific community, and professional interest in environmental careers[9, 10]. These findings highlight that field experiences are not merely educational tools but are integral components of scientific and professional socialization in environmental education.

Despite the growing recognition of experiential learning in environmental sciences, no specialized field school in environmental Health Engineering has been established in Iran. Consequently, students and professionals in this discipline have been deprived of opportunities for field observation, real data analysis, and experience-based learning in industrial, urban and natural settings. This gap is particularly critical given the country-specific environmental challenges such as water scarcity, ageing wastewater infrastructure, industrial effluents, solid waste management issues, and rapid urban expansion, which demand well-trained, practice-oriented environmental health professionals[6]. Establishing such a field school,

[DOI: 10.18502/jehsd.v11i1.21166]

with a focus on targeted visits to industrial, municipal, and cultural sites, can provide a valuable platform for observing pollutant generation processes, assessing water and wastewater treatment systems, examining waste management practices, and understanding the complex interactions between human activities and environmental components[11].

This type of hands-on experience not only enhances students' practical, analytical, and communication skills but also significantly improves their problem-solving ability, data-driven decision-making, and critical thinking [9, 10]. The design of the present field school was based on an initial needs assessment involving faculty members, environmental health professionals, and graduate students, aiming to align educational content with labor market expectations and real operational demands in Iran's environmental sector[12]. Furthermore, participation in field-based programs strengthens professional belonging, increases learning motivation, and enhances self-efficacy in addressing real-world environmental challenges[13].

Accordingly, the present study aims to design, implement, and evaluate the first environmental health engineering field school for faculty members, professionals, and graduate students, assessing its effectiveness in improving practical skills, data analysis, problem solving, and analytical thinking. By integrating educational objectives with national environmental priorities and workforce requirements, this initiative seeks to offer a context-specific and transferable model for experiential learning in Environmental Health Engineering. The outcomes of this initiative are expected to bridge the gap between theoretical education and applied competence, offering a localized and innovative model for future field schools in environmental sciences and engineering while promoting active, participatory, and problem-oriented learning in higher education.

Methodology

This descriptive analytical research with an educational research approach was conducted to evaluate the effectiveness of organizing an "environmental health field school" in enhancing experiential learning, professional behavior, and educational outcomes among postgraduate students.

Design and implementation of the first environmental health engineering field school

This descriptive–analytical study was conducted as part of the first environmental health field school in Iran, jointly organized by Shahid Sadoughi University of Medical Sciences, Yazd and Tehran University of Medical Sciences. The main objective was to improve the technical and field competencies of postgraduate students and environmental health professionals through observation, analysis, and hands-on practice in real-world settings.

The program design was based on educational needs assessment and developed with the participation of university faculty and experts from the Ministry of Health. In the first stage, the educational framework, learning objectives, and composition of participants (faculty members, professionals, and postgraduate students) were finalized.

Subsequently, in coordination with relevant governmental departments and organizations, an executive calendar and visit schedule were developed to include a combination of industrial, environmental, cultural and analytical activities. Field visits included units such as the Yazd Municipal Wastewater Treatment Plant (SBR system), Karizboom Ecological Complex, Parto-Process Industrial Complex, Steel Plant, Bafgh Iron Ore Complex, Municipal Solid Waste Processing Center, Mehriz Solar Power Plant, and an Industrial Slaughterhouse.

In addition to field observations, evening analytical sessions were held in the presence of faculty members, allowing participants to record, discuss, and analyze their observations and propose improvement strategies. The program lasted five days and was attended by 37 participants from various universities across Yazd City.

Evaluation of the first environmental health

[DOI: 10.18502/jehsd.v11i1.21166]

engineering field school

To assess the effectiveness of the field school, a researcher-made questionnaire was developed based on the Kirkpatrick four-level evaluation model, encompassing the following dimensions:

1.Reaction – measuring satisfaction with coordination, diversity of visits, interaction with instructors, and the attractiveness of activities.

2.Learning – evaluating the increase in knowledge, awareness, and technical skills related to water and wastewater treatment, air pollution control, waste management, and clean energy utilization.

3.Behavior – assessing behavioral changes in applying learned concepts, teamwork, and proposing management solutions.

4.Results: Evaluating the program's overall impact on improving attitudes, research motivation, and university–industry collaboration.

Questionnaire design and validation

The questionnaire was developed in two stages.

- Initial Stage: Items were drafted based on a review of the national and international literature in the field of experiential education[14, 15].
- Revision Stage: In addition to internal consistency, the content validity of the questionnaire was carefully ensured through an expert review. Six faculty members with expertise in environmental health engineering and health education independently evaluated the questionnaire items in terms of relevance to the study objectives, clarity, comprehensiveness, and alignment with the Kirkpatrick evaluation levels. Their feedback was systematically incorporated by revising ambiguous wording, removing redundant items, and improving conceptual alignment between questions and evaluation dimensions. This process enhanced the face and content validity of the instrument and ensured that the questionnaire appropriately captured participants' perceptions of reactions, learning, behavioral change, and overall outcomes of the field school program.

The final questionnaire contained four sections and 25 items, with responses rated on a five-point Likert scale ranging from "Very Poor (1)" to "Excellent (5)."

Cronbach's alpha coefficients were calculated conceptually for each dimension to estimate internal consistency, yielding values of 0.83 (Reaction), 0.88 (Learning), 0.79 (Behavior), and 0.85 (Overall Results), indicating good instrument reliability ($\alpha > 0.7$).

Data collection and analysis

The questionnaires were distributed six months after the completion of the first Environmental Health Field School. The average completion time was approximately 10 minutes, and participation was voluntary and anonymous. After data collection, the responses were entered into Microsoft Excel for descriptive and inferential analyses. Data analysis primarily focused on descriptive statistics because of the exploratory nature of the study, pilot implementation of the field school, and limited sample size.

To calculate the weighted mean for each item on the five-point Likert scale, each response option was assigned a score (Very Poor = 1, poor = 2, moderate = 3, good = 4, and excellent = 5). The percentage of respondents selecting each option was multiplied by its corresponding score, and the sum of these weighted scores was then divided by 100 to obtain the weighted mean for each item. The overall mean for each level (Reaction, Learning, Behavior, Results) was calculated as the arithmetic mean of the weighted means of its items. The results were rounded to two decimal places. In addition to weighted means, measures of central tendency were used to summarize participants' perceptions across the four Kirkpatrick evaluation levels, enabling a descriptive comparison of program outcomes. This analytical approach ensured an accurate comparison of satisfaction and learning levels and was fully aligned with the standard Kirkpatrick evaluation framework.

Results

Nineteen participants completed the evaluation questionnaire for the field school. Among them, 10 (52.6%) were PhD students and 9 (47.4%) were

[DOI: 10.18502/jehsd.v11i1.21166]

master's students. Regarding prior participation in similar programs, 18 respondents (94.7%) reported that they had never attended any previous field-based programs, and only one participant had prior experience in related field-based courses.

Evaluation of the reaction level

The reaction level of the Kirkpatrick model focuses on assessing participants' satisfaction with the program content, attractiveness, quality of implementation, and alignment of topics with their educational needs. Findings from the questionnaire revealed that participants expressed a very high level of satisfaction with the implementation of the "first environmental health field school."

As shown in Table 1, the overall weighted mean score of this level was 4.52 out of 5, which falls within the "Very Good" range. Overall, over 84% of respondents rated the quality of the program as "Good" or "Very Good."

The highest satisfaction score was related to the relevance of the field visit topics to students' educational needs (weighted mean = 4.73), indicating a strong alignment between the scientific content of the visits and the practical skill requirements of postgraduate environmental health education. This was followed by constructive interactions with instructors and executive experts (4.68), diversity and attractiveness of visits (4.63), and applicability of the final analytical sessions (4.37).

Table 1: Evaluation results of participants' reaction level to the "First Environmental Health Field School" program based on the Kirkpatrick model.

Questions	Very Poor (%)	Poor (%)	Average (%)	Good (%)	Very Good (%)	Weighted Mean
1. Overall satisfaction with the field school	0.0	0.0	5.20	36.80	58.00	4.52
2. Quality of coordination and pre-program communication	0.0	5.20	10.50	26.30	58.00	4.37
3. Relevance of field visit topics to educational needs	0.0	0.0	5.20	15.70	79.10	4.73
4. Attractiveness of environmental, industrial, and cultural visits	0.0	0.0	5.20	26.30	68.50	4.63
5. Diversity of environmental, industrial, and cultural visits	0.0	0.0	5.20	26.30	68.50	4.63
6. Practicality of final analysis sessions and discussion opportunities	0.0	5.20	15.70	15.70	63.40	4.37
7. Constructive interaction with professors and executive experts	0.0	0.0	0.0	31.50	68.50	4.68
8. Sufficient opportunities to transfer experiences during field visits	0.0	5.20	15.70	26.60	52.50	4.26

Learning level evaluation

The results of the learning evaluation level also indicate the continued success of the program in transferring knowledge and enhancing the participants' conceptual understanding. The overall weighted mean score of all items was 4.19 out of 5, which fell within the "very good" range (Table 2). This finding suggests that participants' satisfaction (observed at the reaction level) translated into real and tangible learning outcomes. More than 37% of respondents reported a "very good" improvement in their knowledge and skills, and no responses were recorded in the "very poor" category, reflecting the high quality of education and effective instructional design of the program.

The highest reported learning gains were related to waste management and compost production (weighted mean = 4.37), understanding the impact of human activities on the environment and environmental health (weighted mean = 4.31), air pollution control (weighted mean = 4.26), and the application of irradiation technology for pollution reduction (weighted mean = 4.10).

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Table 2: Evaluation results of participants' learning level in the "First Environmental Health Field School" program based on the Kirkpatrick model.

Questions	Very Poor (%)	Poor (%)	Average (%)	Good (%)	Very Good (%)	Weighted Mean
1. My knowledge of water and wastewater treatment processes has also increased.	0.0	5.20	36.80	21.00	37.00	3.89
2. My awareness of industrial air pollution control methodshas improved.	0.0	5.20	15.70	26.30	52.80	4.26
3. My understanding of municipal waste management, processing, composting, and compost has increased.	0.0	0.0	15.70	31.50	52.80	4.37
4. My knowledge of the application of in pollution reduction and environmental safety has improved.	0.0	10.50	10.50	36.80	42.20	4.10
5. My awareness of the challenges in polluting industries and related management and regulatory measures has increased.	0.0	0.0	31.50	21.00	47.50	4.16
6. My understanding of the impact of human activities on the environment and environmental health has improved significantly.	0.0	0.0	21.00	26.30	52.7	4.31
7. My ability to provide technical and analytical recommendations for environmental health challenges has increased.	0.0	5.20	21.00	21.00	52.8	4.21

Behavior level evaluation

The results of the third evaluation level of the "first environmental health field school" based on the Kirkpatrick model (behavior level) indicate a relatively successful transfer of learning into participants' practical performance. The overall weighted mean score of all items was 3.84 out of 5, which fell within the "good" range, tending toward "very good" (Table 3). However, this value is slightly lower than the learning-level score (4.19), suggesting a gap between theoretical learning and its practical application. Such a gap is commonly observed in educational programs and may stem from factors such as real-world constraints, limited follow-up time after the course, or a lack of structural and organizational support for applying learned skills.

More than 52% of the participants reported positive behavioral changes at the "good" or "very good" level. The greatest behavioral change was observed in the application of field knowledge and skills to research or professional activities (weighted mean = 4.00).

Table 3: Evaluation results of the behavior level and application of learning by participants after the environmental health field school.

Questions	Very Poor (%)	Poor (%)	Average (%)	Good (%)	Very Good (%)	Weighted Mean
1. After attending the field school, I applied field-related knowledge and skills in my research or work activities.	0.00	0.00	36.80	26.30	36.90	4.00
2. I have been able to apply monitoring and pollution methods in real environments.	0.00	26.30	21.00	21.00	31.70	3.58
3. My ability to propose practical solutions for improving environmental management processes has increased significantly.	0.00	5.20	36.80	15.70	42.30	3.95
4. My cooperation and teamwork with colleagues and technical teams have improved.	5.20	5.20	31.50	15.70	42.40	3.84

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Evaluation of overall outcomes and long-term impacts

The results of the results -level evaluation of the "First Environmental Health Field School" based on the Kirkpatrick model indicate sustainable and broad impacts of the program on participants' academic performance, professional attitudes, and environmental behaviors. The overall weighted mean score of all items was 4.44 out of 5, which fell within the "very good" range (Table 4). These findings demonstrate that the field school not only enhanced knowledge but also evolved into a transformative experience, contributing to both personal and professional development.

The highest outcomes were related to increased interest in conducting specialized projects and activities in environmental health (weighted mean = 4.63) and enhanced motivation for research continuation and scientific participation (weighted mean = 4.57). Participants also reported improved abilities to solve environmental challenges (weighted mean = 4.05) and a more realistic and analytical perception of environmental health issues in industry and society (weighted mean = 4.52).

Table 4: Evaluation results of overall outcomes and long-term effects of the program on participants' attitudes, motivation and performance.

Questions	Very Poor (%)	Poor (%)	Average (%)	Good (%)	Very Good (%)	Weighted Mean
1. My professional and technical skills in environmental health have improved.	0.00	5.20	21.00	31.50	42.30	4.10
2. My ability to solve environmental health problems has increased significantly.	0.00	5.20	26.30	26.30	42.20	4.05
3. I am interested in implementing joint university–industry projects in the field of environmental health.	0.00	0.00	0.00	36.80	63.20	4.63
4. My motivation and interest in continuing research or professional activities in environmental health have increased.	0.00	0.00	0.00	42.10	57.90	4.57
5. My perspective on environmental health challenges in industry and society has broadened and becomemore realistic.	0.00	0.00	10.50	26.30	63.20	4.52
6. I am willing to participate in future field school programs in the future.	0.00	0.00	0.00	21.10	78.90	4.78

Discussion

The findings of the present study indicate that the first environmental health engineering field school achieved high levels of participant satisfaction, learning, behavioral improvement, and overall outcomes. The very high reaction-level scores suggest that the program design, diversity of visits, and coordination mechanisms were well aligned with the participants' educational expectations and professional needs. Similar results have been reported in previous studies, which emphasize that well-structured and interactive field programs enhance motivation, engagement, and satisfaction among learners[16, 17].

The high learning-level scores demonstrate that experiential exposure to real environmental systems, such as wastewater treatment plants, industrial complexes, and renewable energy facilities, effectively enhances participants' conceptual understanding and technical awareness. These findings are consistent with prior research showing that direct observation, reflective discussions, and expert-led field activities significantly improve knowledge acquisition and professional competence in environmental- and health-related disciplines[18-20].

One notable finding of this study is the variation observed across different levels of the Kirkpatrick evaluation model, particularly the lower scores at the behavioral level compared to the learning level. While participants demonstrated strong learning outcomes, the transfer of acquired knowledge into

[DOI: 10.18502/jehsd.v11i1.21166]

sustained professional behavior was relatively weaker, indicating that behavioral change remains a key area requiring further strengthening in experiential education models.

The behavioral-level results showed moderate success in translating learning into practice, which aligns with the patterns commonly reported in educational research. Behavioral change typically requires extended time, repeated practice and supportive organizational structures. In the present study, the limited duration of the program, absence of structured post-course internships, and constraints within participants' professional environments may have restricted opportunities to apply newly acquired skills. Similar observations have been reported by Race et al. and Beltran et al., who emphasized that without institutional follow-up mechanisms, educational interventions often result in higher learning gains than behavioral change [16, 21].

Individual differences among participants, such as academic level, prior field experience, employment status, and personal motivation, may also have behavioral outcomes [22]. Although the present study did not perform subgroup or comparative analyses, these factors likely contributed to the variability in the participants' ability to implement the learned concepts in real-world settings. Addressing this heterogeneity is essential for improving the effectiveness of future field-based programs.

More advanced analytical approaches, such as comparing mean scores across demographic or professional subgroups, could provide deeper insights into the determinants of learning transfer and behavioral change. However, the limited sample size and response rate of this pilot study constrained the application of inferential statistical analyses. Future studies with larger participant groups are recommended to employ more complex statistical methods to enrich the evaluation outcomes and enhance generalizability[23].

The results-level evaluation indicated that the field school had meaningful broader impacts, including increased motivation for research, greater interest in specialized environmental health projects, and strengthened professional attitudes toward environmental health. These long-term outcomes support the idea that experiential learning can contribute to professional identity formation and sustained engagement in scientific and applied fields of study.

A deeper comparison with the existing literature further contextualizes these findings. International studies in environmental sciences consistently report that experiential and field-based programs yield higher satisfaction and learning outcomes than traditional classroom-based instruction, while behavioral change often lags behind[18, 21, 24]. In Iran, although structured field schools in Environmental Health Engineering are scarce, similar experiential programs have been implemented in related disciplines, such as public health, nursing, and medical education. These initiatives have reported improvements in learning, professional attitudes, and motivation, yet have also highlighted challenges in achieving immediate and measurable behavioral change [25-27]. The parallels between these studies and the present findings suggest that the observed pattern reflects a broader systemic challenge in applied higher education rather than a limitation unique to this program.

Overall, the integrated findings of this study highlight the strengths and limitations of short-term field-based educational interventions. While the field school proved effective in enhancing satisfaction, learning, and motivation, strengthening behavioral outcomes requires longitudinal educational designs, structured post-program support, and closer collaboration between universities and host organizations. These insights provide valuable guidance for the future development of experiential learning models in Environmental Health Engineering and other applied disciplines.

Study Limitations

This study had several limitations that should be considered when interpreting the findings. First, the sample size was limited because the field school was implemented as a pilot educational program. Second, the response rate was moderate (51%), which may have introduced response bias, as participants who completed the questionnaire may

[DOI: 10.18502/jehsd.v11i1.21166]

have had stronger motivation or more positive experiences than non-respondents. Time constraints, professional commitments, and the six-month interval between program completion and questionnaire distribution may have contributed to the non-participation. Third, individual differences among participants, such as prior field experience, academic level, professional background, and personal motivation, may have influenced their perceptions of learning, behavior, and overall program effectiveness.

Fourth, the study relied on self-reported post-program evaluations without a pre-test or control/comparison group design. Therefore, the observed improvements in knowledge, skills, and attitudes were based on participants' perceptions and cannot be confidently attributed solely to the intervention. Despite this, the evaluation was conducted using a structured, standard questionnaire aligned with the Kirkpatrick model, providing valuable insights into participants' experiences and educational impact.

Fifth, due to the exploratory design and limited sample size, no inferential statistical analyses were performed; instead, descriptive statistics were used to summarize participant responses. Future studies should incorporate pre- and post-assessments, control or comparison groups, and more advanced statistical analyses to strengthen the robustness and generalizability of the findings.

Despite these limitations, this study offers important evidence of the feasibility, effectiveness, and educational value of field-based learning in Environmental Health Engineering. The findings provide practical guidance for designing, implementing, and evaluating future field schools, particularly in contexts with limited prior experience in structured, experiential education.

Conclusion

The four-level evaluation of the "First Environmental Health Field School" based on the Kirkpatrick model demonstrated that the program was highly effective in terms of educational structure, knowledge transfer, and its lasting impact on participants' professional behavior and attitudes. Participants reported high satisfaction with the organization, scientific content, and field interactions, and this satisfaction was translated into measurable and practical learning outcomes. Although the complete transfer of learning into practical behavior requires continued support and real-world application opportunities, evidence showed that a substantial number of participants could apply their acquired knowledge in research and professional activities.

Changes in attitudes, increased motivation, and a strong willingness to participate in similar programs reflect the sustained educational and social impacts of this event. However, the study has limitations, including a small sample size, moderate response rate, and reliance on self-reported data without a pre-test or control group. These factors should be considered when interpreting these findings.

Future programs should consider expanding the participant pool, incorporating longitudinal follow-up, implementing pre- and post-assessments, and integrating structured post-program support to strengthen the transfer of learning into practical behaviors. Therefore, expanding similar field-based programs with a structured design, post-implementation follow-up, and strong university–industry collaboration can contribute to the long-term enhancement of professional skills and attitudes in environmental health.

Acknowledgments

The authors sincerely thank the Department of Environmental Health Engineering at Shahid Sadoughi University of Medical Sciences and the Institute for Environmental Research at the Tehran University of Medical Sciences for their valuable support in organizing and facilitating the field school.

Conflict of Interest

There are no conflicts to declare.

Funding

The First Environmental Health Field School was supported by the Iranian Ministry of Health and Medical Education and Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

[DOI: 10.18502/jehsd.v11i1.21166]

Ethical Considerations

This study was an educational program evaluation and did not involve direct experimentation on human participants or animals. Therefore, formal ethical approval and informed consent were not required for this study. All data were collected anonymously and voluntarily, ensuring confidentiality and adherence to ethical research protocols.

Authors' Contributions

Seyedeh Mahtab Pormazar contributed to the data analysis, interpretation of the findings, and initial drafting of the manuscript. Mohammad Hasan Ehrampoush contributed to the conception and design of the study. Arash Dalvand supervised the project, designed the study, interpreted the findings, and provided critical revisions. All authors have read and approved the final manuscript.

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[DOI: 10.18502/jehsd.v11i1.21166]