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RESEARCH ARTICLE

How to teach about forest fires effectively: insights from teachers about education for sustainable development

[version 1; peer review: 2 approved with reservations]

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Abstract

Background

Forest fires represent a growing environmental and civil safety challenge across Europe and neighboring regions, with human activity responsible for the vast majority of ignitions. Despite increasing wildfire risks, previous studies indicate that children often lack sufficient knowledge about wildfire prevention, while educational approaches frequently struggle to translate awareness into behavioral change. This study investigates how teachers and sustainability experts perceive effective methodologies for teaching forest fire prevention within the framework of Education for Sustainable Development.

Methods

Using a qualitative focus group design structured through the Mobilization and Mutual Learning approach, the research collected insights from 14 participants representing educators and sustainability experts from several European countries and Turkey. The 75-minute session was transcribed and analyzed using a hybrid inductive–deductive thematic analysis, identifying three primary domains: implementation barriers, methodological suitability, and actionable strategies.

Results

Findings reveal that effective wildfire education depends on the interaction between emotional, institutional, and pedagogical factors. Key barriers include eco-anxiety among students, rigid national

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curricula, and limited experiential contact with natural environments. Participants identified several promising methodologies, including Communication for Development, bio-empathy and narrative-based learning, experiential learning inspired by Deweyan pedagogy, and project-based learning. These approaches were considered effective in bridging the gap between environmental knowledge and behavioral change.

Conclusions

The study proposes a framework linking implementation barriers with participatory teaching strategies capable of fostering long-term sustainability competencies and responsible environmental behavior among young learners. Ultimately, addressing psychological barriers through experiential frameworks transforms students into a vital resource for building more resilient communities.

Plain Language summary

This study explores how to bridge the gap between “knowing” about forest fires and actually taking action to prevent them. Since human activity is responsible for approximately 96% of wildfires in the EU, education is a critical tool for environmental protection. However, traditional teaching often faces hurdles such as student “eco-anxiety”, rigid national curricula, and a lack of direct contact between urban students and natural ecosystems. To address these barriers, the research identifies several effective methodologies: Communication for Development (C4D) encourages students to become active messengers within their families; bio-empathy and storytelling foster emotional connections to nature; and experiential, project-based learning - inspired by Deweyan pedagogy - replaces passive instruction with long-term, hands-on engagement. Ultimately, the findings suggest that moving from episodic lessons to sustained, participatory strategies transform students into a vital resource for building safer, more resilient communities.

Keywords

Forest Fires; Wildfires; Education for Sustainable Development; ESD; Sustainability Education

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Introduction

Forest fires are one of the main risks to civil safety in Europe and Anatolia. As Chen et al. (2026) explain: "High-intensity forest fires have significant destructive impacts on ecosystems and society and are an increasing concern worldwide" (Chen et al., 2026, p. 1; also see Ochoa et al., 2024, p. 2). The Mediterranean is experiencing a surge in larger, more intense forest fires than usual (Mathews & Malfatti, 2024, p. 1065), however, regions located "to the North" are not an exception. For example, Donis et al. (2017) highlight that even Nordic Boreal regions are not immune to forest fires (Donis et al., 2017, p. 1), stressing that forest fires are truly an interregional concern. "The PESETA IV study estimates that the probability of high-to-extreme danger of wildfires will rise nearly everywhere in Europe" (Union Civil Protection Knowledge Network, 2023).

The spatial behavior of wildfire ignitions highlights a critical intersection between human infrastructure and environmental vulnerability. Research consistently demonstrates that fire risk is highest at the wildland-urban and wildland-agricultural interfaces, where proximity to roads, high population densities, and economic activity create frequent opportunities for accidental starts (Ochoa et al., 2024, p. 2). Besides the hotter and more dry climates of the Mediterranean, where both - nature and humans - act as agents of the phenomenon, in Northern regions such as the United Kingdom, Ireland, and southern Sweden, the climate is generally cooler and more humid, making natural fire starts less common. Consequently, human activity becomes the most visible predictor of fire (pp. 6–9). Here, it is important to stress the concern expressed by the EU's Joint Research Centre (2024): "Roughly 96% of wildfires in the EU are caused by human actions, meaning that education and awareness-raising campaigns are an essential part of the solution. As the climate crisis worsens, it is crucial that Europe's population prepares for more frequent and intense wildfires". What makes this issue even more significant is the fact that several scholars have proven that children lack adequate knowledge about wildfires, including forest fires (Şahin, 2025, pp. 592, 594; Salam et al., 2025, p. 149; Demirkaya et al., 2024, p. 14; Söküt Açar et al., 2019).

Stibe et al. (2022) stress a very important point: "Intense trainings and knowledge sharing not necessarily lead to expected behavioral results. Is there a gap between what people know and what they do?" (Stibe et al., 2022, p. 3). Addressing the human element of wildfire prevention requires more than just informing the public; it necessitates a fundamental shift in how environmental responsibility is taught (Stibe et al., 2022, p. 3). According to Towers (2015), based on the results of wildfire education research, "there is an urgent need for further research in the design and delivery of children's bushfire education (p. 189). In this context, ESD serves as a critical tool that empowers individuals, instead of simply indoctrinating them, to drive sustainable progress by weaving environmental protection, social equity, and economic responsibility into the learning experience. Through the study of global issues like biodiversity and climate change, it equips the next generation with the strategic capacities required for an ethical and sustainable lifestyle (UNESCO, 2020).

Therefore, the aim of this study is to identify the most prominent issues in the forest fire education across Europe and Turkey, and to propose a toolkit of theories for addressing specific teacher encountered issues.

Methods

The study utilized a focus group interview design, an effective method for collecting qualitative data through interactive and directed discussions with multiple individuals simultaneously. The goal was to explore and clarify the perceptions, opinions, and views of experts and practitioners regarding Education for Sustainable Development (ESD) methodologies for forest fire prevention (Salmons, 2023).

To ensure a systematic and meaningful dialogue, the focus group was prepared and structured according to the Mobilization and Mutual Learning (MML) approach, as explained by Yilan et al. (2025, p. 5). Developed through EU-funded initiatives like BIOVOICES, Biobridges, and LIFT, this approach shapes the participatory process by defining four key parameters: "what for", "what", "with whom," and "how":

1. What for (objectives) - the primary objective was to identify and evaluate ESD methodologies specifically adapted for teaching forest fire prevention to school-age children, considering the principle "Knowing does not mean doing".

2. What (contents to be discussed) - the starting point was the definition of "Sustainable Development" and "ESD" using real-time Mentimeter word clouds to establish a common baseline. The core contents included several theory-grounded stimuli - thematic videos covering concepts such as Communication for Development (C4D), John Dewey's Principles, Bio-empathy, and Project-Based Learning (PBL). Theories were chosen based on the most relevant ESD practices and the Development Goals, as well as issues mentioned by the teachers in the first part of the interview session.

3. With whom (stakeholders involved) - in line with the MML focus on diverse stakeholder groups, the sample consisted of 14 participants (excluding the moderator) recruited from the "Fireproof the Future" project consortium entities. This included three sustainability experts representing Latvia, Spain, and Sweden, and eleven educators representing Turkey, Poland, and Italy.

4. How (formats and supporting tools for engagement) - the focus group employed a hybrid format to facilitate international collaboration: 13 participants attended in-situ (including the moderator), and two participants joined via Google Meet. To ensure group activation and better engagement, the moderator used digital stimuli to elicit opinions on the adaptability of each methodology to local teaching contexts.

Data collection and analysis

The 75-minute session was automatically transcribed using Microsoft Word *Dictate* tool. To ensure data integrity, the researcher-moderator monitored the speech-to-text output in real-time, correcting linguistic nuances as they occurred. The final transcript was condensed when feasible to ensure the analysis focused on thematic outcomes.

A manual qualitative content analysis was performed on the verbatim transcripts using methodology proposed by Braun and Clarke (2006) and Kleinheksel et al. (2020), using a sequential hybrid inductive-deductive analytical design. First, we used Thematic Analysis (Braun & Clarke, 2006) to inductively identify the teachers' immediate pedagogical needs during the first part of the session. These themes then informed the deductive selection of further theoretical stimuli (e.g., Dewey, PBL), which were evaluated using Qualitative Content Analysis (Kleinheksel et al., 2020; Krasnova, 2025, p. 44) to determine their suitability for forest fire prevention.

Both inductive and deductive approaches were used to categorize responses into three thematic domains: Implementation Barriers (Identifying administrative and psychological challenges (e.g., "eco-anxiety")); Methodological Suitability (Evaluation of the presented ESD theories); Actionable Strategies (Synthesizing educator/expert suggestions for learning).

The analysis was conducted in the following stages:

1. Familiarization and Data Cleaning: The researcher - moderator reviewed the condensed transcripts against the real-time notes to ensure linguistic accuracy and to contextually ground the "condensed" sections. After that, the transcripts were shared with the interview participants for the final approval.

2. Deductive Coding (Thematic Mapping): Initial codes were derived from the theory-grounded stimuli (e.g., C4D, Dewey's Principles, PBL) presented during the session. Meaning units were tagged based on how participants evaluated the suitability of these specific ESD methodologies for forest fire prevention.

3. Inductive Coding (Emergent Themes): New codes were generated from the participants' lived experiences, – such as specific students' family settings or the psychological impact of "eco-anxiety" mentioned by educators.

4. Categorization and Synthesis: Codes were grouped into three primary thematic domains: Methodological Suitability, Implementation Barriers, and Actionable Future Strategies. This synthesis allowed for a comparison of perspectives between the high-level sustainability experts and the frontline educators across the four participating countries.

Validity procedures

The study followed MML-aligned validity standards:

A) Credibility: Ensured by the diverse, multi-national expert sample.

B) Authenticity: Achieved through thematic saturation during the interactive dialogue.

C) Transferability: The procedure and stimulus materials are detailed in the B2SHARE data repository (Krasnova, 2026).

D) Confirmability: Guaranteed by real-time transcription monitoring and manual verbatim review.

While the focus group provided rich qualitative insights, several methodological limitations must be acknowledged. Geographic and sample scope: the findings are based on a purposive sample of 14 international stakeholders across four specific countries (Italy, Turkey, Poland, and representatives from Latvia/Spain/Sweden). While this diversity supports the MML goal of inclusive dialogue, the limited participant number may not fully represent the pedagogical landscape of the entire European Union and/or Turkey. Also it is worth noting that interview has been conducted only with one group.

The thematic analysis and final categorization into the Thematic Network (Implementation Barriers, Methodological Suitability, etc.) were performed manually, introducing the potential for moderator interpretation bias, as well as the choice of the presented theories (stimuli) has been based solely on the moderator - researcher's interpretation and expertise to identify education theories relevant to the issues mentioned by the focus group. To ensure confirmability and reduce coding bias, a formal validation procedure was implemented - following the initial analysis, participants were given the opportunity to review the final results to acknowledge the validity of the researcher's interpretations and ensure the findings accurately reflected their professional perspectives.

Results

Focus group interviews

The qualitative analysis of the focus group discussion identified how educators and sustainability experts perceive the applicability of Education for Sustainable Development (ESD) methodologies for forest fire prevention education among school-age learners. Following the hybrid analytical strategy combining inductive thematic analysis and deductive qualitative content analysis, participant responses were organized into three overarching thematic domains:

1. Implementation Barriers
2. Methodological Suitability
3. Actionable Future Strategies

These domains reflect both participants' lived pedagogical experiences and their evaluation of theory-grounded methodologies introduced during the Mobilization and Mutual Learning (MML)-structured session. A comprehensive breakdown of these domains, including their associated subthemes, analytical descriptions, and illustrative meaning units, is presented in Table 1:

The findings of this study demonstrate that effective implementation of Education for Sustainable Development (ESD) for forest fire prevention depends not solely on curriculum content but on the interaction between emotional, institutional, and pedagogical dimensions of learning. Using a Mobilization and Mutual Learning framework, the focus group enabled educators and sustainability experts to collectively evaluate how theoretical ESD methodologies translate into classroom realities.

We can summarize the findings and the proposed actions in the following flow chart:

Implementation Barriers

↓

Methodological Suitability

↓

Actionable Strategies

↓

ESD Behavioral Outcomes

In the following sections, therefore, first, implementation barriers will be analyzed further, following an elaboration on methodological suitability of several ESD approaches, which will be analyzed and adapted to the interviewed teachers' needs.

Table 1. Perception of ESD implementation barriers, methodological suitability and actionable future strategies among teachers (compiled by the author).

Thematic domain	Subtheme	Analytical description	Example meaning units (participants)
Implementation Barriers	Emotional sensitivity/eco-anxiety	Emotional reactions influencing engagement with disaster-related content	"Children are often scared of fire" (P3)
			"If we only show destruction, they shut down emotionally" (P8)
			Students associate fires with real-life trauma experiences (P3)
	Curriculum rigidity	Structural limits preventing ESD integration	"Our curriculum is very rigid" (P2)
			Limited instructional hours for environmental disasters (P2)
			ESD implemented indirectly through subjects rather than systematically (P14)
	Teacher preparedness	Lack of conceptual clarity and training	"Teachers need training to understand SD" (P14)
			Educators unsure how to translate SD into classroom practice (P14)
	Experiential disconnect	Reduced interaction with natural ecosystems	"Some kids have not been to a real forest" (P11)
			Urban students lack environmental reference points (P11)
			Parks insufficient substitutes for real ecosystems (P11)
Methodological Suitability	Communication for Development (C4D)	Behaviour change through participation and dialogue	"Students should feel a personal stake in the forest" (P14)
			Students influencing family sustainability habits (P14)
			Community fire-watch projects suggested (P3)
	Experiential/ Deweyan learning	Learning through interaction and experience	Outdoor excursions increase respect for nature (P9)
			Observing forest recovery improves engagement (P14)
			Practice preferred over theoretical instruction (P11)
	Bio-empathy & storytelling	Emotional connection fostering responsibility	Fire framed as ecological transformation (P8)
			"Forest Stories" approach humanizes ecosystems (P8)
			Literature used to evoke empathy toward nature (P13)
	Project-Based Learning (PBL)	Long-term interdisciplinary engagement	Designing fire-resistant villages (P2)
			Semester monitoring of forest regeneration (P13)
	Inclusive pedagogy	Multiple participation pathways	Narrative, simulation, or technical outputs allowed (P4)
			Anonymous polling reduces participation anxiety (P1)
			Student choice strengthens belonging (P10)

Table 1. *Continued*

Thematic domain	Subtheme	Analytical description	Example meaning units (participants)
Actionable Future Strategies	Long-term engagement	Sustained sustainability learning	Semester-based environmental projects (P13)
			Community-based prevention initiatives (P3)
	Hybrid outdoor–digital learning	Combining experiential and technological learning	Fire-spread simulations using terrain models (P8)
			Digital tools complement limited field access (P6)
	Teacher role transformation	Shift toward facilitation and co-learning	"Teachers become messengers and facilitators" (P6)
			Students construct their own sustainability values (P11)
			Active learning replaces passive instruction (P1)

Implementation Barriers

Psychological and Emotional Challenges

Participants consistently emphasized the emotional complexity associated with teaching forest fire topics. Educators reported that students frequently associate fire with danger, loss, or personal experience, which may lead to disengagement or anxiety when destructive imagery dominates instruction. Teachers therefore highlighted the importance of pedagogical framing that promotes awareness without reinforcing fear.

Several educators noted that focusing exclusively on disaster narratives may produce emotional withdrawal among younger learners. Consequently, approaches emphasizing ecological regeneration and forest recovery were perceived as more emotionally sustainable learning pathways.

Institutional and Curriculum Constraints

Administrative limitations emerged as a significant cross-national challenge. Participants described national curricula as highly structured, allowing limited time for interdisciplinary environmental education. ESD was often implemented indirectly through biology, geography, or ethics subjects rather than as an integrated pedagogical framework.

Additionally, educators expressed uncertainty regarding ESD conceptualization itself, identifying insufficient professional training as a barrier to confident implementation. This indicates that institutional readiness remains a determining factor influencing methodological adoption.

Limited Experiential Contact with Natural Environments

Another recurrent theme concerned students' reduced interaction with natural ecosystems. Teachers observed that many urban students lack direct experience with forests, complicating attempts to foster environmental responsibility through classroom-based instruction alone. Participants therefore link behavioral change to experiential exposure rather than theoretical knowledge acquisition.

Discussion - methodological suitability of ESD approaches

Communication for development (C4D)

A central finding across all thematic domains concerns the persistent gap between environmental knowledge and behavioral change. Participants repeatedly emphasized that students may understand fire risks cognitively while failing to translate this understanding into preventive behavior. This confirms broader ESD and C4D literature identifying the transition from *awareness* to *action* as a core educational challenge (e.g. Stibe et al., 2022). Citing Colle (2008, pp. 96-97):

> "Communication is a vital partner in initiatives that involve voluntary behaviour change. The two words 'voluntary' and 'behaviour' are very important (…) most of the effort we put into development communication involves helping people develop themselves and their communities, and this inevitably involves voluntary actions (…) Where people have options to change their ways of life, communication becomes important in informing, persuading, listening, data gathering, educating, training, and managing change. Thus, we emphasize the idea that development communication is 'strategic communication'"

Instead of just "persuading", strategic communication involves listening and data gathering to understand *why* the individual is resisting. Resistance is often a result of top-down approaches; C4D emphasizes stakeholder participation and creativity to find solutions that the community actually values. Rather than ad-hoc posters, a systematic approach uses data and careful planning to stimulate positive behavior by addressing the underlying motivations of the audience (Colle, 2008, pp. 96–97).

The Communication for Development (C4D) approach was widely evaluated as effective in addressing the perceived gap between environmental knowledge and behavioral transformation. Participants highlighted that traditional instruction frequently prioritizes factual transmission, whereas C4D promotes dialogue, participation, and community engagement. Rather than positioning learners as passive recipients of environmental information, educators perceived students as potential agents influencing families and communities. This shift aligns with transformative learning perspectives within sustainability education.

Educators suggested that involving students as communicators within families and local communities could extend learning outcomes beyond the classroom, thereby strengthening preventive behaviors related to forest fire risk.

Bio-empathy and narrative-based learning

Bio-empathy and storytelling approaches were identified as suitable tools for cultivating emotional connection with nature. Participants reported that narrative perspectives - such as forest storytelling or ecosystem-based character framing - encourage students to perceive environmental protection as a shared ethical responsibility. Such approaches were considered especially effective for younger learners by transforming environmental issues into relatable experiential narratives. For example, a study by Salam et al. (2025) stresses the same idea: "Children may learn more about catastrophe risks and acceptable actions by including disaster education in the curriculum and employing engaging tactics such as moral dilemmas in comics and social studies" (Salam et al., 2025, p. 152). In disaster education, teachers may use short visual stories with characters and dialogue to present situations related to disasters. The images make the scenario easier for children to understand and remember.

The interview further highlights the importance of emotional regulation within environmental pedagogy. Forest fires represent emotionally charged phenomena, particularly in regions directly affected by climate-related disasters. Participants reported that fear-based approaches may unintentionally generate eco-anxiety or disengagement among learners.

A study by Şahin (2025) approves of such hypothesis. Author investigated the perceptions and emotional responses of 5–6-year-old children regarding forest fires through a qualitative phenomenological approach. Conducted with 20 participants in the Marmara Region of Turkey, the research utilized children's drawings and semi-structured interviews to uncover their internal understanding of environmental disasters. The findings revealed that children possess a significant level of environmental empathy, with 14 out of 20 participants expressing deep sadness and 9 expressing fear when discussing the topic. While the children correctly identified human activity - specifically carelessness and littering - as a primary cause of fires, they also demonstrated a strong sense of social responsibility by proposing active solutions such as calling the fire department or helping to pour water. However, the research also noted that some children's understanding of fire prevention and ecosystem relationships remained superficial, suggesting that current educational curricula should be strengthened with experiential and participatory learning to foster long-term environmental consciousness (Şahin, 2025).

Interview participants expressed that methodologies grounded in bio-empathy and narrative learning emerged as effective alternatives to eco-anxiety induced approaches. By framing fire within ecological cycles of regeneration, educators were able to maintain awareness while fostering hope and responsibility. These findings support arguments that emotional engagement constitutes a prerequisite for sustainable behavioral learning rather than an auxiliary outcome. "Furthermore, these educational activities can have a larger influence on families and communities by empowering children to disseminate disaster preparation knowledge to their own families and communities" (Salam et al., 2025, p. 153).

Dewey and project-based learning

Across focus group participating countries, experiential learning was consistently identified as essential for meaningful ESD implementation. Limited student interaction with natural environments was perceived as a major barrier preventing internalization of sustainability values. Outdoor learning, field visits, and observation-based activities were therefore viewed not as enrichment but as necessary pedagogical conditions. For this issue, the moderator - researcher proposed several concepts - experiential learning, Deweyan pedagogy and Project-Based Learning. Since such learning approaches are highly practical, accessibility/inclusion issues have to be taken into account.

Experiential learning and deweyan pedagogy

Methodologies grounded in experiential learning principles received strong support. Outdoor activities, excursions, and observation-based learning were perceived as essential for connecting abstract sustainability concepts with tangible environmental realities. Participants particularly valued approaches presenting fire within ecological cycles of destruction and regeneration, as these narratives fostered curiosity and emotional engagement while mitigating fear responses.

John Dewey is one of the most prominent thinkers in the field of education, while his ideas still constitute a big part of modern teaching approaches around the globe. "John Dewey believed that students learn from human experiences" (Holt, 2020, p. 142) - an approach called "experimentalism" (p. 142). For example, "When individuals are allowed to flourish in an environment like the lab school that affords the experimentalist approach to be used, individual thinking and creating will be enhanced" (p. 144).

Dewey, as explained by Holt (2020), just like the interviewed teachers, believed that learning is dependent on personal, especially for younger learners, family experiences: "Each individual comes with unique experiences, or lack of experiences, that make this process very personal." (pp. 144–146). For example, Australian research, conducted in the wake of the devastating 2009 "Black Saturday" bushfires, highlights a critical gap between children's general awareness and their actual ability to perform protective actions. This case study involved interviews with 141 children and 70 parents to determine how young learners construct their understanding of fire hazards. The findings revealed that children who are not actively involved in household preparedness often harbor dangerous misconceptions, such as believing they can outrun a fire or find safety in a bathtub filled with water. Conversely, children who are directly included in household mitigation activities demonstrate a far more sophisticated understanding of fire behavior, including the risks of radiant heat and ember attacks. These insights were subsequently used to develop evidence-based educational tools, such as the Li'l Larrikins animated series and the Triple Zero Kids Challenge, which aim to replace these intuitive misconceptions with practical, life-saving knowledge (Towers, 2015, p. 179).

The integration of these international perspectives highlights a global necessity for child-centered wildfire education that moves beyond general awareness to address specific cognitive gaps. While research in Turkey (Şahin, 2025) emphasizes that children as young as five already possess high levels of environmental empathy and a sense of social responsibility toward nature, the Australian case study warns that without direct involvement in preparedness, this empathy can be undermined by dangerous misconceptions. For instance, children who are not actively involved in household mitigation often believe they can outrun a fire or find safety in a bathtub, whereas those included in disaster planning develop a sophisticated understanding of fire behavior, such as the dangers of radiant heat and embers. This suggests that for Education for Sustainable Development to truly empower the next generation, curricula must evolve to include experiential learning and family-inclusive activities that ground emotional concern in practical, evidence-based survival strategies (Towers, 2015, p. 179).

While Deweyan Pedagogy argues that learning must be grounded in experiential principles, such as outdoor activities and excursions, to connect abstract concepts to "tangible environmental realities". Project-Based Learning (PBL) takes that philosophical "experience" and turns it into a method - a structured, possibly a long-term project. Instead of just visiting a forest once (Dewey), students engage in collaborative problem-solving over time to understand that forest's specific fire risks (PBL) (Kokotsaki et al., 2016, pp. 273–274).

Project-based learning and Inclusive education

Participants emphasized that long-term projects enable interdisciplinary integration, collaborative problem-solving, and learner autonomy. Project-Based Learning (PBL) emerged as the most adaptable methodology across educational contexts. "PBL stems from Dewey and Small's philosophy, advocating for learning by doing. Inspired by Dewey, Kilpatrick developed the 'project method' in 1918, first formalizing a PBL approach" (Levin & Major, 2025, p. 3), and is a more practical side of the theory heavy Deweyan philosophy. PBL might be especially beneficial for students with challenging behaviours.

Childhood is a mix of "culture and nature". To truly support students - especially those with behavioral issues that affect their academics - the school system needs a more "interdisciplinary" approach that combines various fields of study rather than sticking to a narrow, test-driven curriculum. Citing Holt (2020, p. 146):

> These [Dewey's] collective ideas are important today as we are identifying a variety of behaviors that are identified as challenging or disruptive in the classroom. The focus on individual behavior is especially important (…) All needs, including the social needs of a student, must be met in order to for the child to be successful. Educators need an understanding of the different learning styles that best fit the students. These learning styles may be hands-on, verbal, visual, auditory, or a combination of these. This may also vary from subject to subject with the individual child.

It is worth noting that "project-based instruction is not more demanding than traditional instruction in terms of resources and time and can be implemented with few resources, inside the school building and within the time allocated for the study of particular topics" (Kokotsaki et al., 2016, pp. 271–272).

Inclusive classroom strategies further strengthen methodological effectiveness by allowing students multiple modes of participation and expression. Flexible assessment formats were perceived as reducing performance anxiety while supporting engagement with complex sustainability topics.

Recommendations - actionable future strategies based on the theories

Transition from episodic lessons to long-term engagement

Participants advocated replacing isolated environmental lessons with sustained project-based activities. Suggested practices included monitoring forest regeneration, designing fire-resistant settlements, and implementing community awareness initiatives. These strategies were viewed as operationalizing ESD's central objective of transforming knowledge into action.

Hybrid outdoor–digital learning models

Educators proposed combining outdoor learning experiences with digital simulations illustrating fire behaviour under varying environmental conditions. This hybrid approach was considered capable of overcoming geographical and institutional limitations while maintaining experiential depth.

Transformation of teacher roles

Across discussions, participants articulated a shift in professional identity from instructor toward facilitator. Teachers increasingly viewed themselves as mediators of dialogue, supporting students in constructing personal environmental values and social responsibility.

This transformation reflects alignment with participatory ESD and Communication for Development principles emphasized during the focus group process.

Conclusions

This study contributes empirically grounded insights into how internationally diverse educators interpret and operationalize ESD methodologies within disaster-prevention education. By combining inductive practitioner perspectives with deductive theoretical evaluation, the research advances understanding of how participatory learning environments can operationalize sustainability goals at the school level.

The analysis demonstrates that effective forest fire prevention education within ESD requires simultaneous integration of cognitive understanding, emotional engagement, and participatory practice. While implementation barriers remain primarily institutional and psychological, educators identified experiential, communicative, and inclusive methodologies as capable of bridging the gap between environmental awareness and behavioral change. Educators identified Communication for Development, Bio-empathy, Narrative-Based Learning, Deweyan Pedagogy and Project Based Learning as effective approaches for forest fire teaching.

Synthesizing the findings, the proposed framework model illustrates how implementation barriers can be mediated through participatory and experiential methodologies, ultimately supporting behavioural

outcomes related to forest fire prevention. The results suggest that successful ESD initiatives require alignment between:

- emotional engagement,
- experiential interaction,
- inclusive participation,
- and community-oriented communication.

Forest fire education therefore becomes not only an environmental topic but a context for developing sustainability competencies and civic responsibility. Citing Towers (2015): "children represent a major resource for the development of safer, more resilient communities" (p. 187).

Ethics and consent

Ethical oversight for this study was provided by the Project Ethics Committee of the "Fireproof the Future" consortium (Project ID: 2024–1-IT02-KA210-SCH-000250679). As the participating organizations do not maintain a standing institutional review board, an ad hoc ethics committee was established within the project consortium to review the research protocol.

This ad hoc committee consisted of representatives from the project's specialized operational units, including the Project Management, Financial Management, Dissemination, and Evaluation teams. The research design was reviewed and approved during a virtual meeting in September 2024, and the final protocol was registered under reference number 2–05/11/2024–1 in the internal, password-protected record-keeping system of the United Efforts Network for Progressive Development (UENPD) and the consortium.

The study was conducted in strict accordance with the EU General Data Protection Regulation (GDPR) and the policies and national legislation of the hosting organizations. Written, informed consent was obtained from all 14 participants by the project coordinator prior to data collection. Participants were fully informed of the study's purpose and their right to withdraw. To ensure confidentiality, all published data have been anonymized, with participants assigned identification numbers (e.g., P1, P2) rather than names.

To ensure confirmability and provide a final layer of ethical validation, the finalized version of the anonymized interview transcripts was shared with all 14 participants following the initial analysis. This process allowed participants to review the researcher's interpretations, verify that the findings accurately reflected their professional perspectives, and confirm that the anonymization effectively protected their identities. Formal approval for the publication of these anonymized data was received from all participants prior to the final submission of the manuscript.

Data and software availability

Underlying data

The dataset supporting the findings of this study is openly available in B2SHARE: Focus Group Transcript - Sustainable Education for Development: Forest Fire Pedagogy. https://doi.org/10.23728/b2share.pk974-d7868.

Data citation: Krasnova, D. (2026). Focus Group Transcript - Sustainable Education for Development: Forest Fire Pedagogy [Data set]. B2SHARE. https://doi.org/10.23728/b2share.pk974-d7868.

The dataset includes:

- Focus Group Transcript - Ftf by DK.pdf (condensed transcript of a 75-minute focus group interview involving 14 sustainability experts and educators from Turkey, Poland, and Italy).
- Evaluation of pedagogical frameworks (qualitative discussions and evaluations of Education for Sustainable Development methodologies, including Communication for Development (C4D), John Dewey's Principles, Bio-empathy, and Project-Based Learning).
- Implementation challenge records (identifying barriers such as eco-anxiety and administrative rigidity in forest fire prevention education).

- Focus group instruments (metadata and URLs for tools used during the session, including Mentimeter, Google Meet, and Microsoft Word Transcription).

- Reference list of pedagogical stimuli (a comprehensive collection of educational videos used to facilitate expert discussion during the focus group).

Data are available under the terms of the Creative Commons Attribution 4.0 International license.

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- Istituto Tecnico Statale "G. Garibaldi" (Marsala, Italy) - Project Coordinator

- United Efforts Network for Progressive Development (Latvia)

- 19 Mayıs Anadolu Lisesi (Turkey)

- Zespol Szkol Ekonomii i Uslug (Poland)

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Sapta Suhardono
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Please explain how the participants were selected. What sampling strategy was used (e.g., purposive, convenience)? On what criteria were the educators and sustainability experts included?

Is the sample size (n = 14) sufficient, and did it reach thematic saturation? Please provide justification and explain how saturation was assessed.

Please explain technically how the “condensing” process of the transcripts was conducted. Were any parts of the data removed? If so, how was the original meaning preserved during this process?

How were validity and reliability ensured in the analysis?
Was the coding conducted by more than one coder?
Was intercoder agreement assessed?
How was potential researcher bias addressed?

Please clearly distinguish which parts of the analysis were inductive and which were deductive. The current description appears to combine both, but the boundaries between them are not sufficiently explicit.

Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: My area of expertise is environmental science, with a particular focus on anthropogenic–environmental interactions and related environmental issues.

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

Reviewer Report 30 April 2026

https://doi.org/10.21956/openreseurope.25261.r72688

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Reni Juwitasari
Mae Fah Luang University, Chiang Rai, Thailand

1. Is the work clearly and accurately presented and does it engage with the current literature?
The manuscript is clearly structured and accessible, with a coherent progression from the problem of increasing wildfire risks to the role of Education for Sustainable Development (ESD) in addressing the knowledge–behavior gap. The focus on teacher and expert perspectives provides valuable pedagogical insight and aligns well with current sustainability education agendas. However, the engagement with the literature would benefit from further development to strengthen its analytical positioning. In particular, there is a notable gap in relation to **existing education curriculum literature**. While the manuscript advocates for strengthening forest fire education within ESD, it does not sufficiently examine how such content is currently embedded within formal curricula or delivered through subjects such as biology or geography. Importantly, the empirical data itself suggests that forest fire topics are already present in teaching practice

(e.g., integrated within biology lessons), indicating that the issue may relate more to **pedagogical delivery and integration** rather than the absence of content.
From a social science perspective, this also reflects a broader point that environmental learning is not simply a matter of adding content, but of understanding how **knowledge is translated into practice within institutional and social contexts**, including curriculum structures, teacher preparedness, and students' lived experiences. While the manuscript identifies the knowledge–behavior gap as a central concern, it does not fully situate this within discussions on how behavior is shaped by contextual, social, and experiential factors beyond cognitive awareness.
To strengthen its contribution, the manuscript would benefit from engaging more explicitly with literature on:

- **ESD curriculum integration**, and
- **environmental and disaster education in formal schooling systems**,

in order to clarify whether the contribution lies in **curriculum expansion** or **pedagogical transformation within existing structures**.
Addressing these points would significantly enhance both the academic rigor and the practical relevance of the manuscript.

2. Is the study design appropriate and is the work technically sound?

The study design, based on a focus group structured through the Mobilization and Mutual Learning (MML) approach, is appropriate for an exploratory qualitative investigation of teacher perspectives. The inclusion of educators and experts from multiple contexts, combined with the use of pedagogical stimuli, provides a structured environment for reflective discussion and comparative insight.
At the same time, the scope of the design remains limited to a single focus group (n=14), and the data reflects **participant perceptions rather than observed pedagogical outcomes or behavioral change**. As such, the study is best understood as **exploratory and interpretive in nature**. Some of the claims in the manuscript extend slightly beyond what this design can support, particularly when referring to pedagogical "effectiveness."
This can be readily addressed by **aligning the framing of the study with its qualitative scope**, emphasizing that the findings represent **perceived pedagogical possibilities and practitioner insights**, rather than empirically validated outcomes.

3. Are sufficient details of methods and analysis provided to allow replication by others?

The manuscript provides a useful overview of the methodological approach; however, further clarification would strengthen analytical transparency and reproducibility. Comparison with the transcript indicates that the focus group discussion is **facilitated through the introduction of pedagogical stimuli**, with participant responses often reflecting engagement with these prompts. This suggests that the study would be more accurately described as a **stimulus-based or guided qualitative focus group**, rather than a fully emergent discussion. Making this distinction explicit would improve methodological clarity and help readers better understand how the data was generated.
In addition, the analytical process would benefit from:

- a clearer presentation of the **coding framework** (themes, subthemes, and definitions)
- inclusion of **illustrative excerpts** linking raw data to thematic interpretation
- a brief explanation of the **researcher's role and analytical decisions**

The reference to "condensed transcripts" also warrants clarification, particularly regarding how data reduction was conducted and how meaning was preserved. These additions would enhance transparency and allow the study to meet expected qualitative research standards.

4. If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable. This study applies a qualitative design.
5. Are the conclusions drawn adequately supported by the results?
The conclusions are generally aligned with the themes identified in the focus group discussion, particularly in relation to perceived barriers such as eco-anxiety, curriculum rigidity, and limited experiential learning, as well as the potential value of experiential, project-based, and communication-based pedagogies.
However, some statements regarding pedagogical "effectiveness" and behavioral outcomes would benefit from more cautious framing. Given that the study is based on participant perspectives rather than measured outcomes, it would be more accurate to present these findings as **perceived or suggested pedagogical potentials** rather than demonstrated effects.
Reframing the conclusions in this way, and emphasizing their relevance for **curriculum design and classroom practice within existing constraints**, would strengthen the internal consistency of the manuscript and align the claims more closely with the qualitative evidence.

Summary of Required Revisions to be Considered

1. Clarify methodological approach and coding process
2. Explicitly describe stimulus-based data generation
3. Strengthen engagement with:
    - ESD curriculum integration
    - environmental and disaster education literature
4. Moderate claims about effectiveness
5. Improve data transparency (transcript condensation and stimuli documentation)

With these revisions, the manuscript has a clear path toward becoming a **strong qualitative contribution to ESD pedagogy and curriculum development**, particularly in translating teacher perspectives into actionable, context-sensitive educational practices.

Is the work clearly and accurately presented and does it engage with the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

Are all the source data and materials underlying the results available?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Disaster, Education, Traditional Knowledge related to Sustainable Development and Sustainability in the Global South with specific topics of disaster risk reduction and resilience, education for sustainable development (ESD) and sustainability (EFS), and local knowledge for disaster and climate change.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.