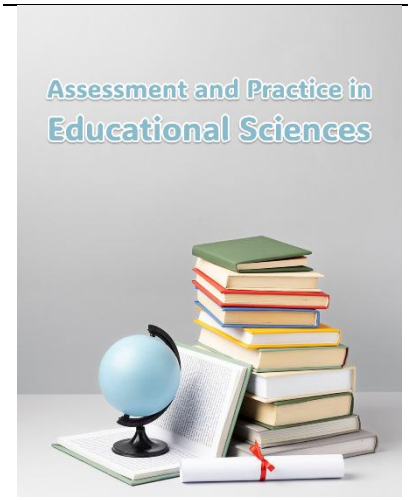
Assessment and Practice in Educational Sciences



Identification of Curriculum Components for Environmental Ecosystem Protection with a Passive Defense Approach

ABSTRACT

The aim of this study was to identify the curriculum components for environmental ecosystem protection through a passive defense approach. The present research employed a qualitative meta-synthesis method. The research setting included all Iranian articles (2009–2023) and international articles (2007–2023). The sampling method in the qualitative meta-synthesis section was purposive, continued until data saturation, and resulted in 31 articles selected through a screening process from an initial pool of 91 articles. Data analysis was conducted based on a hierarchical structure of open concepts, organizing concepts, and overarching themes. The findings revealed that the curriculum for environmental ecosystem protection with a passive defense approach includes the following dimensions: In the materials/resources dimension, four components were identified: in-person field visits, simulation software, the internet, and supplementary books. In the space dimension, three components were identified: spatial interpretation, engagement with space, and sense of place. In the time dimension, two components were identified: out-of-school time and school time. In the grouping dimension, three components were identified: interest-based grouping, subject-based grouping, and agency-based grouping. In the evaluation dimension, four components were identified: formative assessment, practical assessment, intentional assessment, and multi-dimensional assessment.

Keywords: Curriculum, Ecosystem Protection, Environmental, Passive Defense.

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Introduction

Environmental sustainability and the preservation of ecosystems have emerged as global imperatives, particularly in the face of escalating environmental threats and anthropogenic pressures. In this context, education plays a pivotal role in fostering

ecological literacy, shaping pro-environmental behaviors, and building societal resilience. A fundamental aspect of this endeavor is the design and implementation of environmental curricula that are not only scientifically grounded but also culturally relevant and adaptable to emerging security paradigms, such as passive defense. Passive defense refers to non-military measures aimed at minimizing the vulnerability of systems, communities, and infrastructures to environmental and man-made threats without direct confrontation (1, 2). The integration of passive defense principles into environmental education curriculum design is a novel yet urgent requirement in the current era of complex environmental challenges.

In recent years, scholars and policymakers have increasingly recognized the value of embedding passive defense strategies within educational systems to enhance community preparedness and reduce systemic vulnerabilities (3, 4). This need is particularly pressing in countries facing compound risks such as natural disasters, climate change, and environmental degradation. According to Marzouqi et al. (5), a structured and validated curriculum framework for passive defense education can serve as a foundational tool for integrating such resilience-based concepts into schools. Similarly, Naseri Jahromi et al. (6) argue that an effective passive defense education system must be grounded in a holistic understanding of both environmental and educational contexts.

To ensure effectiveness, environmental protection curricula must address key educational components—content, space, time, evaluation, and grouping—within a pedagogically sound and contextually adaptable framework. Bezi et al. (7) emphasize the importance of curriculum design models, such as the Aker approach, which focus on aligning learning content with learners' real-life contexts and promoting sustainability competencies. These competencies are central to fostering environmental values and preparing learners to deal with ecological uncertainty and risk. Additionally, Ni et al. (8) highlight the role of a "green curriculum" in cultivating students' pro-environmental behaviors and values, noting its potential for shaping attitudes toward sustainability when framed around local environmental issues and cultural identity.

One significant methodological contribution to environmental education has been the development of place-based and interdisciplinary learning models. Zangori (9) demonstrated how place-based environmental education units such as "Energy and Your Environment" enhance students' energy literacy and promote localized environmental awareness. Similarly, Dillon and Herman (10) emphasize the importance of contextualized environmental learning experiences that connect students with their immediate ecological surroundings. Such approaches not only foster deeper learning but also build the affective and cognitive bases required for environmental stewardship and civic responsibility.

However, as Akbari et al. (11) observed, there often exists a misalignment between the intended, implemented, and achieved curriculum in environmental subjects. This disconnect can be exacerbated when curricular designs fail to integrate passive defense principles effectively. According to Saeedinia et al. (12), validation of curriculum elements through stakeholder engagement and field-based assessment is critical to ensure that the implemented curriculum meets both environmental learning and security resilience objectives.

The practical implementation of environmental education is further complicated by the evolving nature of instructional technologies and pedagogical strategies. For example, the flipped classroom model, as explored by Omrani et al. (13), has shown promise in increasing student engagement in human-environment subjects. By extending learning beyond traditional classroom structures, such models create opportunities to integrate passive defense topics into interactive, inquiry-based learning environments. Satterfield et al. (14) similarly support multimodal curriculum reform, advocating for adaptive, learner-centered ecosystems that respond dynamically to institutional and social changes.

Furthermore, environmental education curricula must respond to challenges in assessment and evaluation. Saeedi and Meiboudi (15) highlight the inadequacy of current evaluation frameworks in Iran's green schools, where assessment tools often fail to measure the depth of environmental understanding and behavioral change. Their findings align with the need for multi-

dimensional evaluation models that consider not only cognitive outcomes but also emotional engagement, moral responsibility, and behavioral intentions toward environmental protection.

In addition to formal education structures, informal educational platforms, such as environmental museums, play a critical role in embedding passive defense concepts into public consciousness. As Chermahini and Mardomi (16) demonstrate, natural disaster museums can function as experiential learning centers that link environmental phenomena with defense strategies, thereby enhancing public preparedness and ecological awareness. This suggests a broader role for curriculum designers to incorporate out-of-school learning opportunities into the formal curriculum framework.

Building ecological awareness also requires a deliberate focus on cultivating ecological thinking from early education stages. Jumanov and Tolibjonovna (17) argue that ecological thinking develops best through interdisciplinary curricula that highlight relationships between human actions and environmental consequences. Likewise, Umarjonovna (18) advocates for interactive teaching methodologies that make environmental protection content both accessible and actionable for school-aged learners. These approaches not only enhance engagement but also prepare students to apply environmental knowledge in real-world contexts—a core principle of passive defense education.

Globally, trends in STEM education also reflect a growing emphasis on ecological systems thinking. Falloon et al. (19) analyze how STEM curricula in Australia are being reshaped through ecological systems frameworks, which offer a natural entry point for integrating sustainability and resilience education. Such systemic approaches resonate with the goals of passive defense, which prioritize interconnectedness, adaptability, and long-term risk reduction.

On a broader level, the concept of the "learning ecosystem" offers a compelling lens for understanding how learners interact with curriculum structures in dynamic environments. Ab Jalil et al. (20) propose that learners' agility and readiness must be nurtured through adaptive curricula that anticipate future challenges and emphasize environmental and technological literacies. This readiness becomes particularly vital in contexts where learners must respond to environmental disruptions and security threats, underlining the relevance of passive defense concepts in general education.

Incorporating passive defense into environmental curricula is not merely a theoretical exercise; it also has clear strategic implications for national policy and community resilience. Azadkhani et al. (21) used the example of Ilam city to illustrate how passive defense principles can be operationalized to reduce vulnerability to environmental hazards, such as flooding. This illustrates the curriculum's potential to contribute to real-world resilience planning when designed with local vulnerabilities in mind.

Finally, as Abedi and Golahmadi Shargh (1) observe, the evolving scope of passive defense now encompasses a wide range of socio-environmental domains, from infrastructure protection to educational resilience. Their analysis underscores the need for curricula that are responsive to contemporary threats while remaining grounded in sustainable and inclusive educational principles. In this sense, curriculum development must function as both a pedagogical and a strategic endeavor, aligning educational goals with national priorities for environmental security and sustainability.

In conclusion, the development of a curriculum for environmental ecosystem protection with a passive defense approach requires a multi-dimensional, evidence-based, and forward-thinking framework. Thus, this study aims to identify the curriculum components for environmental ecosystem protection through a passive defense approach.

Methods and Materials

The present study is applied in purpose and follows a qualitative meta-synthesis approach. The seven-step meta-synthesis method proposed by Sandelowski and Barroso (2007) was employed in this research.

The research setting in the qualitative meta-synthesis section included all articles related to the curriculum for environmental ecosystem protection with a passive defense approach, published during the years 2009–2023 for Iranian articles and 2007–2023 for international articles. Purposeful sampling was applied until data saturation was achieved. Through the screening process, 31 articles were selected from an initial pool of 91 articles.

Inclusion criteria for the articles included: publication in reputable journals (with valid indexing), publication within the last 20 years, sufficient data for extraction, and structured format.

Data collection was carried out through library research, and the data collection tool was note-taking. Articles were retrieved from valid domestic and international databases for analysis.

Validation and credibility were ensured using four criteria: credibility, transferability, confirmability, and dependability. To ensure the reliability of the qualitative part of the study, inter-coder agreement was calculated using Cohen's Kappa coefficient in SPSS version 28. The obtained Kappa coefficient was 0.841, indicating high reliability and expert agreement on the findings.

Data analysis in the qualitative section was conducted based on the categorization of open codes, organizing concepts, and overarching concepts.

Findings and Results

In this study, data analysis followed the hierarchical categorization of open concepts, organizing concepts, and overarching concepts. From 66 extracted open concepts, organizing concepts were derived, and finally, overarching concepts were formulated as the curriculum dimensions, which include: materials/resources, space, time, grouping, and assessment of the teaching–learning curriculum.

Question 1: What are the dimensions and components of the environmental ecosystem protection curriculum with a passive defense approach in the materials/resources dimension?

Based on the findings presented in Table 1, and according to the open codes obtained, the curriculum model for environmental ecosystem protection with a passive defense approach in the materials/resources dimension includes four organizing concepts: in-person field visits, simulation software, internet, and supplementary books.

Table 1. Curriculum Components for Environmental Ecosystem Protection with Passive Defense Approach (Materials/Resources Dimension)

Open Concepts	Organizing Concepts
Use of environmental simulation software (code 23), visual consequences of environmental damage (code 18), environmental experience-based learning strategies (code 16), use of students' environmental experiences (code 16), awareness of renewable resources (code 11), awareness of non-renewable resources (code 11), revision of environmental education tools (code 4), use of multi-modal teaching–learning tools (code 7), use of creative educational materials (code 8), appropriate tools and resources for illustrating nature's landscapes (code 15)	Simulation Software
Use of integrated technology in environmental curriculum (code 22), use of tech tools to encourage students (code 22), videos of protected areas (code 9), videos of wildlife refuges (code 9)	Internet
Use of supplementary books in learning activities (code 12), environmental books tailored to next-generation needs (code 14), visuals showing environmental destruction (code 21)	Supplementary Books
Use of diverse educational materials (code 8), use of demonstrative materials (code 8), visits to national parks (code 9), organizing environmental trips (code 31), providing outdoor learning opportunities (code 30), visits to sites of environmental degradation (code 20), visits to environmental museums (code 20), awareness of hazardous materials (code 13), development of environmental learning opportunities (code 19)	In-Person Field Visits

Question 2: What are the dimensions and components of the curriculum in the **teaching–learning space** dimension?

According to Table 2 and based on the open codes, the curriculum model in this dimension includes three organizing concepts: spatial meaning-making, spatial engagement, and sense of place.

Table 2. Curriculum Components for Environmental Ecosystem Protection with Passive Defense Approach (Teaching–Learning Space Dimension)

Open Concepts	Organizing Concepts
Creating space for respect, benevolence, gratitude, and support for the environmental ecosystem (code 6)	Sense of Place
Place meaning-making in environmental education (code 23), creating a sense of place in environmental education (code 23), creating an ethical space for ecosystem preservation (code 6)	Spatial Meaning-Making
Use of multi-modal learning spaces (code 7), use of diverse learning times (code 7), curriculum in open-air environments (code 25), blended learning (classroom and non-classroom) (code 24), research-centered learning environments for environmental protection (code 19)	Spatial Engagement

Question 3: What are the dimensions and components of the curriculum in the **teaching–learning time** dimension?

According to Table 3, the curriculum model in this dimension includes two organizing concepts: out-of-school time and school time.

Table 3. Curriculum Components for Environmental Ecosystem Protection with Passive Defense Approach (Teaching–Learning Time Dimension)

Open Concepts	Organizing Concepts
Use of extracurricular teaching time (code 8), extending environmental education time through various methods (code 12)	Out-of-School Time
Identifying the timing of ecotourism (code 15), environmental harm by time (code 17), current environmental needs (code 18), future environmental needs (code 18)	School Time

Question 4: What are the dimensions and components of the curriculum in the teaching–learning grouping dimension?

According to Table 4, the curriculum model includes three organizing concepts: interest-based grouping, topic-based grouping, and agency-based grouping.

Table 4. Curriculum Components for Environmental Ecosystem Protection with Passive Defense Approach (Grouping Dimension)

Open Concepts	Organizing Concepts
Grouping students based on interest for environmental conferences (code 10), grouping for identifying environmental attitudes (code 28), ecological identification of the environment (code 29)	Interest-Based Grouping
Group projects on environmental topics (code 10), group education on new environmental laws (code 27), grouping for environmental literacy education (code 28), grouping for teaching environmental ethics (code 26)	Topic-Based Grouping
Grouping students to report on environmental organizations (code 10), grouping for environmental activities (code 12), social responsibility for environmental protection (code 28), ecological identification (code 29)	Agency-Based Grouping

Question 5: What are the dimensions and components of the curriculum in the teaching–learning assessment dimension?

As shown in Table 5, the curriculum model includes four organizing concepts: formative assessment, practical assessment, intentional assessment, and multi-dimensional assessment.

Table 5. Curriculum Components for Environmental Ecosystem Protection with Passive Defense Approach (Assessment Dimension)

Open Concepts	Organizing Concepts
Assessment of acquired curricular knowledge (code 1), challenges in environmental education assessment (code 2), use of multi-dimensional assessments (code 7), evaluation of ethical responsibility in environmental protection (code 28)	Multi-Dimensional Assessment
Formative assessment (code 3), adaptability of environmental education for ecosystem protection (code 19)	Formative Assessment
Process-oriented evaluation (code 3), knowledge of environmental assessment methods (code 5), use of active practical assessment methods (code 8)	Practical Assessment
Evaluation opportunities in environmental education (code 26), assessment of human-nature relationships (code 18)	Intentional Assessment

Based on the open codes, organizing concepts, and overarching themes outlined in Tables 1 to 5, the curriculum model for environmental ecosystem protection within the dimensions of materials/resources, space, time, grouping, and assessment in teaching–learning contexts is depicted in Figure 1.

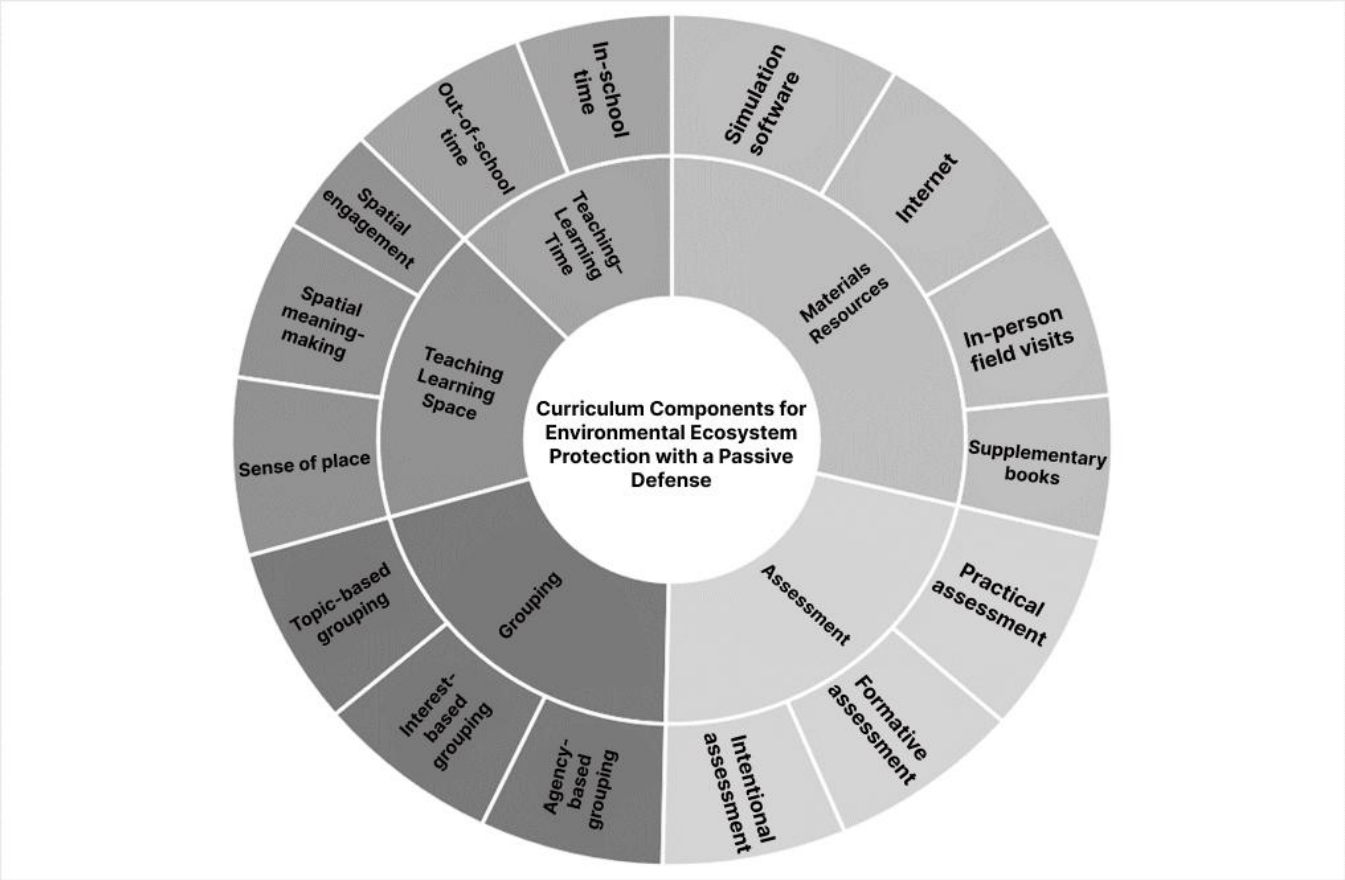

Figure 1. Curriculum Model for Environmental Ecosystem Protection with a Passive Defense Approach.

Discussion and Conclusion

The present study aimed to identify and validate the components of a curriculum model for environmental ecosystem protection based on a passive defense approach, utilizing qualitative meta-synthesis. The findings confirmed five major curriculum dimensions—materials/resources, teaching–learning space, teaching–learning time, grouping, and assessment—each comprising a set of organizing components derived from the analysis of 31 national and international studies. These dimensions collectively offer a comprehensive framework for integrating passive defense strategies into environmental education, highlighting the importance of multi-contextual learning, learner engagement, time adaptability, collaborative learning, and multidimensional assessment.

In the **materials/resources** dimension, four core components were identified: simulation software, internet resources, supplementary books, and in-person field visits. This finding reflects a growing emphasis on combining traditional and modern educational tools to foster environmental awareness. Bezi et al. (7) support this hybrid approach by emphasizing the value of incorporating diverse resources such as digital tools and experiential learning materials in environmental education. Likewise, Ni et al. (8) argue that technological integration and contextualized content delivery through green curricula significantly influence pro-environmental attitudes. These resources also align with Falloon et al.'s (19) ecological systems analysis, which

promotes leveraging technological tools and localized content in science and environmental curricula. Notably, field visits emerged as a critical factor, emphasizing the experiential nature of ecosystem education and passive defense. This is consistent with Dillon and Herman's (10) findings that place-based environmental education deepens students' ecological understanding and fosters stewardship.

The **teaching–learning space** dimension included spatial meaning-making, engagement, and sense of place. The emergence of these themes underlines the importance of contextualized and immersive learning environments in environmental education. Zangori (9) illustrates how a strong sense of place enhances students' connection with the local environment and their motivation to participate in sustainability efforts. Similarly, Omrani et al. (13) showed that flipped learning environments increase student engagement and offer greater flexibility, which is critical for teaching environmental and defense-related topics. The findings suggest that learners need to internalize environmental values through emotional and cognitive interaction with physical spaces, reinforcing Saeedi and Meiboudi's (15) argument on the inadequacy of conventional classroom-bound models in promoting ecological behavior.

In the **teaching–learning time** dimension, the components were classified into "in-school" and "out-of-school" learning periods. This division reflects a growing recognition of the importance of non-formal educational timeframes for deep learning. Ab Jalil et al. (20) emphasize the necessity of preparing learners for future learning ecosystems through flexible, non-linear educational structures that extend beyond classroom hours. Moreover, passive defense education, by its nature, must be embedded in daily learning cycles and community-based experiences, supporting the view of Arash and Shahla (2) that passive defense is as much a societal responsibility as it is an institutional mandate. The identification of time as a structural curriculum element further confirms Khaki's (4) argument that resilience-building must occur across all educational timelines, especially through extracurricular and intersessional activities.

The **grouping** dimension revealed three components: interest-based, topic-based, and agency-based grouping. This reflects a constructivist approach to curriculum design where collaboration, learner autonomy, and social responsibility play central roles. Jumanov and Tolibjonovna (17) and Umarjonovna (18) both argue that grouping strategies that foster discussion, shared inquiry, and collaborative problem-solving promote ecological thinking and civic responsibility. These grouping models also reinforce the findings of Satterfield et al. (14), who showed that learner-centered and agency-enhancing approaches lead to systemic educational change and sustained learning outcomes. The alignment between agency-based grouping and passive defense education is particularly critical, as it encourages students to take ownership of environmental risks and develop problem-solving skills rooted in real-world contexts.

In the **assessment** dimension, four main components emerged: formative, practical, intentional, and multidimensional assessment. This comprehensive assessment framework supports the findings of Saeedi and Meiboudi (15), who highlight the lack of effective evaluation mechanisms in Iran's green schools. The findings also resonate with Saeedinia et al. (12), who emphasize the importance of validating environmental curricula based on diverse learning outcomes, including cognitive, behavioral, and moral dimensions. By integrating multiple forms of assessment, including ethical and experiential evaluations, this study aligns with the evolving view that environmental education must be assessed not only for knowledge acquisition but also for attitudinal and behavioral transformation. Moreover, the component of intentional assessment corresponds with Dillon and Herman's (10) emphasis on aligning educational goals with measurable outcomes, especially in interdisciplinary and sustainability education.

The results of the current study are also consistent with Marzouqi et al. (5), who advocate for a curriculum framework that operationalizes passive defense principles in secondary education. Their validated model shares structural similarities with the five dimensions found in this study, particularly in terms of emphasizing practical content delivery and ethical reasoning.

Similarly, Naseri Jahromi et al. (6) stress that the successful implementation of passive defense curricula must go beyond theoretical instruction and engage students in real-world problem-solving activities.

This research also corroborates the argument of Abedi and Golahmadi Shargh (1), who emphasize the expanding role of passive defense in contemporary educational policy, especially in enhancing societal resilience against environmental threats. By identifying educational materials, spatial dynamics, time structures, grouping models, and assessments as core curriculum elements, the current study provides an operational schema for integrating passive defense into environmental education. Moreover, the integration of ecological systems thinking into curriculum design, as advocated by Falloon et al. (19), further validates the multi-layered nature of the model developed in this study.

Finally, the study supports the policy-oriented work of Azadkhani et al. (21), who demonstrate how curriculum design rooted in passive defense can inform vulnerability mapping and disaster risk reduction at local levels. The curriculum components identified in this study can serve as educational tools for fostering the necessary awareness, preparedness, and action strategies in regions facing environmental threats. The holistic and multi-dimensional nature of the proposed model positions it as a significant contribution to the broader discourse on sustainable development, educational resilience, and environmental citizenship.

While the study provides a comprehensive framework for integrating passive defense into environmental education, it is limited by the scope of its data sources. Only articles published between 2007 and 2023 were included, potentially excluding valuable older foundational works. Furthermore, the study relied solely on qualitative meta-synthesis; quantitative validation of the proposed model was not performed. Additionally, the analysis is restricted to documented curriculum elements and does not account for actual classroom practices or student experiences, which may yield further insight into curriculum effectiveness.

Future studies should undertake empirical testing of the proposed curriculum model in diverse educational contexts, including urban and rural schools, to assess its adaptability and effectiveness. Longitudinal research tracking the behavioral and attitudinal outcomes of students exposed to such curricula can offer deeper insights into long-term impacts. It is also recommended that researchers investigate teacher training needs and institutional readiness for implementing passive defense strategies in environmental education. Moreover, comparative studies across countries with similar environmental risks can enhance the generalizability of findings.

Educational policymakers should incorporate the identified components into national curriculum development guidelines, ensuring that environmental education programs address both sustainability and resilience. Curriculum designers should collaborate with passive defense experts to produce locally relevant learning materials and field-based learning modules. Teachers should be trained in participatory, interdisciplinary, and inquiry-based teaching approaches that align with passive defense principles. Finally, schools should be supported in creating flexible learning spaces and time structures that enable dynamic, student-centered learning about environmental risks and protection strategies.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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