Al-Ishlah: Jurnal Pendidikan
Vol.18, 1 (March, 2026), pp. 198-207
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v18i1.8138

Child-Friendly Schools Meet Green Education: A Bibliometric Mapping of Trends and Synergies in School Management Research

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ARTICLE INFO

Keywords:

child-friendly education;
green school management;
environmental education;
bibliometric analysis

Article history:

Received 2025-06-27
Revised 2026-01-13
Accepted 2026-03-02

ABSTRACT

Research on Child-Friendly Schools (CFS) and Green School initiatives has expanded significantly over the past decade; however, these two frameworks are often examined separately despite their shared emphasis on holistic and sustainable school development. This study aims to map the intellectual structure, research trends, and emerging synergies between child-friendly education and green school management. A bibliometric analysis was conducted on 312 peer-reviewed documents indexed in the Scopus database from 2010 to 2024. Publications were retrieved using structured keyword combinations related to child-friendly schools, green schools, sustainability, and environmental education in school contexts. After data cleaning and keyword normalization, analyses were performed using VOSviewer and Biblioshiny to examine publication trends, citation patterns, co-authorship networks, keyword co-occurrence, and thematic clustering. Findings indicate a marked increase in publications after 2019, reflecting heightened global attention to sustainable and inclusive education aligned with the Sustainable Development Goals. Keyword co-occurrence analysis reveals a thematic shift from infrastructure-oriented sustainability toward holistic approaches integrating student participation, eco-humanism, and whole-school governance models. Four major thematic clusters were identified: green school policies, student participation and behavior, eco-friendly infrastructure, and values-based holistic education. However, collaboration networks remain regionally concentrated, and interdisciplinary integration between child rights and environmental governance research is still limited. The results suggest that integrating child-friendly and green school frameworks offers a promising pathway toward inclusive and sustainability-oriented school management. Future research should prioritize longitudinal, comparative, and interdisciplinary studies to strengthen evidence-based models that align environmental responsibility with child-centered educational principles.

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1. INTRODUCTION

A Child-Friendly School (CFS) is an educational institution grounded in the protection and fulfillment of children's rights, including the rights to quality education, safety, health, participation, and freedom from violence and discrimination. Beyond its protective function, CFS is increasingly recognized globally as a strategic framework for enhancing students' cognitive, emotional, and social learning outcomes by fostering inclusive, participatory, and supportive learning environments. In Indonesia, the implementation of CFS policies has served as a preventive mechanism against rights violations within schools (Dwi et al., 2020), reflecting a broader international commitment to rights-based education that places learners at the center of educational practice.

Concurrently, the green school concept has gained global prominence as an educational response to escalating environmental challenges. Green schools embed sustainability principles into school governance, infrastructure, and curriculum, aiming to cultivate environmental awareness, responsible behavior, and ecological literacy among students. By integrating environmental education into daily school practices, green schools contribute not only to environmental preservation but also to improved student engagement and long-term learning outcomes related to sustainability competencies (Salazar et al., 2024).

Internationally, several countries have begun integrating child-centered and sustainability-oriented educational frameworks. Bhutan's Green School for Gross National Happiness, Indonesia's Adiwiyata program, and whole-school sustainability models in Sweden and Turkey illustrate how environmental values can be aligned with holistic and inclusive education (Sulistyarini et al., 2022; Kuswati et al., 2024) While these initiatives demonstrate practical convergence between CFS and green school principles, scholarly research has largely examined these approaches in isolation.

Existing studies tend to focus either on child-friendly education or on environmental sustainability in schools, overlooking systematic analyses of how these frameworks intersect at the conceptual, policy, and institutional levels. Although prior research indicates that combining child-centered pedagogy with sustainability education can enhance student well-being, engagement, and environmental awareness (Verma & Grover, 2022), there remains limited understanding of the intellectual structure, research trends, and key scholarly contributions that shape this emerging intersection. This gap is further compounded by uneven policy implementation and disparities in institutional capacity across regions (Rajab & Breesam, 2024).

Therefore, this study aims to address this gap by conducting a bibliometric analysis of research on child-friendly schools and green school concepts. Specifically, it seeks to map the evolution of scholarly discourse, identify dominant themes and influential publications, and reveal patterns of collaboration within this interdisciplinary field. By systematically analyzing the existing literature, this study contributes to a clearer conceptual alignment between CFS and green school frameworks and offers evidence-based insights to support the development of sustainable, inclusive, and child-centered educational models at the global level.

2. METHODS

This study employed a bibliometric research design to systematically map and analyze scholarly publications related to child-friendly schools and green school concepts. Bibliometric analysis is a quantitative approach used to examine patterns of scientific production, citation behavior, and knowledge networks in a given research field (Donthu et al., 2021). This method was chosen because it enables the synthesis of large volumes of academic literature and supports the identification of research trends, thematic structures, and influential contributions in an objective and reproducible manner.

The bibliographic data were retrieved exclusively from the Scopus database, selected for its comprehensive coverage of peer-reviewed international publications and its suitability for bibliometric research. Data collection was conducted using a structured title–abstract–keyword search with the following search terms: "child-friendly school", "green school" OR "green school initiatives",

"sustainable education", and "environmental education in schools". These keywords were chosen to capture both the educational and environmental dimensions of the study focus.

To ensure relevance and quality, explicit inclusion and exclusion criteria were applied. The study included publications that

1) addressed child-friendly schools, green schools, or sustainability in school education;
2) were published between 2010 and 2024 to reflect recent academic developments;
3) were written in English; and
4) were categorized as peer-reviewed journal articles, review papers, or conference proceedings.

Publications such as editorials, book chapters, notes, reports, and non-indexed documents were excluded, as they lack standardized peer-review processes or complete bibliographic metadata.

Following data extraction, a multi-stage data validation process was conducted to ensure accuracy and consistency. First, duplicate records were automatically removed. Second, bibliographic metadata—including author names, institutional affiliations, keywords, and references—were manually checked to identify incomplete or inconsistent entries. Third, keyword normalization was performed by merging synonymous and variant terms (e.g., "child-friendly school" and "child-friendly schools") to reduce fragmentation in the analysis. To enhance reliability, ambiguous records and keyword classifications were cross-checked to minimize potential bias.

The validated dataset was analyzed using VOSviewer and Biblioshiny, two widely used tools for bibliometric mapping and visualization. Four analytical procedures were applied. First, citation trend analysis examined annual publication and citation counts to identify the growth and evolution of research interest over time. Second, co-authorship network analysis mapped collaboration patterns among authors and institutions, using network links and node strength to identify influential contributors. Third, keyword co-occurrence analysis identified frequently used terms and conceptual linkages, revealing core research topics and emerging themes. Finally, thematic clustering was conducted by grouping keywords into clusters based on their co-occurrence frequency and relevance scores, allowing for the identification of dominant thematic areas and intersections between child-friendly school management and green school initiatives.

Through this systematic and transparent methodological procedure, the study ensures analytical rigor and reproducibility, while providing a comprehensive overview of the intellectual structure and research trends within the field.

3. FINDINGS AND DISCUSSION

3.1 Citation Trends: Mapping the Growth of Research (2010–2024)

Publication trends reveal a substantial surge in scholarly output over the past two decades, with particularly pronounced growth occurring after 2020. This escalation reflects a sharp rise in academic attention to sustainable education, green schools, and child-friendly schools, coinciding with heightened global awareness of the climate crisis and the increasing recognition of the need to cultivate environmentally responsible behavior from an early age. As international policy frameworks such as the Sustainable Development Goals and Education for Sustainable Development (ESD) gained greater prominence, educational research began to respond more actively to environmental and social sustainability agendas.

Document analysis further indicates a steep increase in the volume of publications during the 2021–2024 period. The surge in citation counts observed in 2022 and 2023 corresponds with intensified global discourse on climate action, curriculum reform, and whole-school sustainability approaches. During this phase, several highly influential studies rapidly gained academic visibility. For instance, Salazar's study on the impact of green school certification programs in Chile attracted substantial citations within a short timeframe, signaling its relevance to policy-driven educational reform. Similarly, the work of Karaarslan-Semiz and Sund, which examines whole-school approaches to ESD

implementation in Sweden and Türkiye, contributed significantly to international discussions on systemic school transformation.

Thematic analysis of recent literature reveals a growing dominance of topics such as pro-environmental behavior, whole-school sustainability models, and sustainable school design. This shift indicates a movement away from conceptual discussions of environmental awareness toward applied research focusing on policy implementation, institutional practices, and educational infrastructure. An increasing number of studies now explore eco-friendly building designs, passive technologies such as courtyards, and the active involvement of school communities in green initiatives, reflecting a more practice-oriented and solution-driven research agenda.

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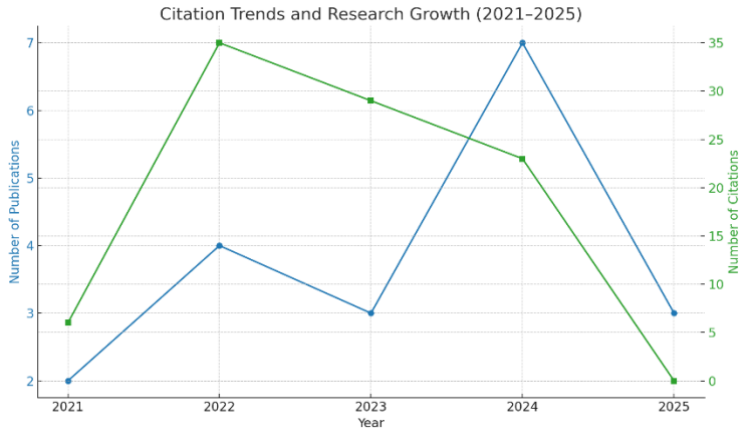

Figure 1. Citation Trends and Research Growth Produced with VOSviewer

The visualization shows that research output and citation impact fluctuate but display an overall upward momentum during the 2021–2025 period. In 2021, the field recorded a relatively low output with only 2 publications and approximately 5 citations, indicating an early stage of intensified scholarly attention. This was followed by a notable increase in 2022, when publications doubled to 4 articles and citations peaked at around 35, suggesting that several influential studies published during or before this period rapidly attracted academic attention. In 2023, the number of publications slightly declined to 3, while citations remained high at approximately 30, reflecting continued referencing of earlier impactful works. The most pronounced growth in publication volume occurred in 2024, with 7 publications, marking the highest output across the observed years; however, citations decreased to about 25, consistent with the shorter time available for newer studies to accumulate references. By 2025, publication output fell back to 3 articles and citations dropped sharply to around 5, likely reflecting incomplete citation accumulation rather than reduced research relevance. Overall, the pattern confirms a surge in academic productivity after 2021, alongside a time-lag effect in citations, where earlier publications tend to generate higher citation counts than more recent ones.

3.2 Co-authorship Networks: Identifying Collaborative Hubs

The analysis of collaboration networks reveals an increasingly expansive pattern of cooperation, both geographically and across disciplinary boundaries, within scholarship on green schools and child-friendly education. Several authors and research groups emerge as key *bridging nodes* that connect child-centered educational perspectives with sustainability-oriented school research. In particular, research teams affiliated with Universitas Negeri Jakarta play a mediating role by integrating pro-environmental behavior, character education, and student participation—core principles of child-friendly schools—into broader discussions of green school implementation. Similarly, scholars from Stockholm University and the University of Vechta function as conceptual connectors by linking whole-

school sustainability frameworks with pedagogical and institutional dimensions of education for sustainable development (ESD), thereby bridging environmental governance and learner-centered approaches.

Additional bridging contributions are evident in cross-regional collaborations. Researchers from Universidad del Bío-Bío and Universidad de Concepción in Chile connect environmental policy-driven initiatives, such as green school certification, with empirical analyses of children's behavioral change, particularly in waste management and environmental responsibility. Meanwhile, scholars from the University of La Laguna extend the interdisciplinary scope by linking sustainable school design and arts education, highlighting how physical learning environments can support both ecological goals and child-friendly learning experiences. Collectively, these actors facilitate knowledge transfer across regions and disciplines, strengthening conceptual integration between child-friendly and green school paradigms.

From an analytical perspective, the collaboration network demonstrates clear benefits, including the cross-fertilization of educational theory, environmental psychology, architecture, and engineering, which enhances the practical relevance and policy applicability of green school initiatives. However, the network also reveals notable gaps. Collaboration remains concentrated in specific regions—particularly parts of Asia and Europe—while Africa and the Middle East are underrepresented. Furthermore, direct collaboration between researchers focusing explicitly on children's rights and those specializing in environmental infrastructure and technology remains limited. These gaps indicate the need for broader geographic inclusion and deeper interdisciplinary integration, especially between social sciences and technical fields, to develop more holistic, scalable, and context-sensitive models of child-friendly and environmentally sustainable schools.

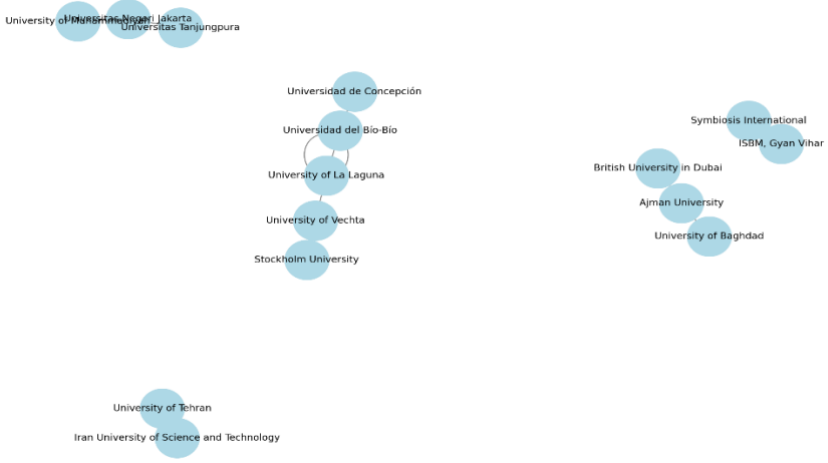

Figure 2. Co-authorship Networks: Identifying Collaborative Hub produced with VOSviewer

3.3 Keyword Co-occurrence: Dominant and Emerging Research Themes

An analysis of keywords in green school–related publications reveals a clear temporal evolution of research themes over time. During the earlier phase of the literature, particularly between 2010 and 2015, dominant keywords such as *green schools*, *sustainability education*, and *pro-environmental behavior* emerged as foundational concepts, reflecting an initial focus on schools as vehicles for environmental awareness and behavior change. Subsequently, in the period from approximately 2016 to 2020, the prominence of the *whole-school approach* increased, indicating a shift toward more systemic and institutional perspectives on sustainability that emphasize the integration of environmental values into school policies, curricula, and organizational culture. The appearance of *Gross National Happiness (GNH)* during this phase further reflects the influence of holistic educational models, particularly those originating from Bhutan, which align environmental sustainability with student well-being and child-centered development.

More recent publications, especially from 2021 onward, demonstrate the emergence of new thematic keywords that signal a conceptual deepening of the field. Terms such as *eco-humanism*, *green infrastructure*, and *school engagement* have gained visibility, marking a transition from primarily infrastructure-oriented or policy-driven approaches toward culturally and behaviorally grounded sustainability frameworks. The concept of *eco-humanism*, in particular, represents a significant theoretical development, as it integrates environmental ethics with humanistic and child-centered values. This perspective reinforces the principles of child-friendly schools by emphasizing students' emotional well-being, moral development, and active participation, while simultaneously fostering ecological responsibility. In this sense, eco-humanism functions as a conceptual bridge between child-friendly education and green school practices, framing sustainability not merely as an environmental objective but as a holistic educational ethos.

Similarly, the increasing prominence of *green infrastructure* reflects a growing interest in how physical learning environments—such as eco-friendly building designs and passive technologies—can support both environmental sustainability and child-friendly learning experiences. The emergence of *school engagement* underscores the expanding recognition that successful green school initiatives depend on the active involvement of the entire school community, including students, teachers, parents, and administrators. Collectively, these temporal and thematic shifts illustrate a paradigm change in the literature, in which sustainability is no longer conceptualized solely in terms of physical infrastructure, but increasingly understood as a dynamic interaction between environmental design, institutional culture, and child-centered educational practices.

Figure 3. Keyword Co-occurrence: Dominant and Emerging Research Themes produced with VOSviewer

3.4 Thematic Clustering: Aligning Child-Friendly School Management with Green School Initiatives

The bibliometric analysis categorizes the existing literature into four major thematic clusters, each representing a distinct yet interconnected approach to integrating green school initiatives with child-friendly school management principles. While these clusters collectively demonstrate the growing maturity of the field, they also reveal persistent implementation barriers and notable research gaps that warrant further scholarly and policy-oriented attention.

3.4.1 Green School Policies and Programs

This cluster focuses on institutional policies and government-led initiatives designed to embed environmental sustainability within educational systems. Prominent examples include Indonesia's *Adiwiyata* program (Sulistyarini, 2022; Mutia, 2025), which promotes environmentally responsible behavior through school-based activities aligned with national standards, and Chile's Green School Certification program (Salazar et al., 2024), which incentivizes sustainable practices through formal recognition mechanisms. While these studies underscore the importance of regulatory frameworks, policy coherence, and incentive-based governance in driving environmental transformation, they also

reveal implementation barriers related to uneven resource distribution, institutional capacity, and regional socio-economic disparities. Schools in under-resourced contexts often face challenges in meeting certification requirements or sustaining program outcomes. Future research would benefit from comparative policy analyses and longitudinal studies that examine how policy-driven green school initiatives evolve over time across diverse socio-economic and institutional settings.

3.4.2 Student Participation and Behavior

This cluster emphasizes the active role of students in cultivating pro-environmental behavior through participatory and experiential learning initiatives. Empirical studies by Salazar et al. and Meitiyani et al. demonstrate that student involvement in environmental projects enhances ecological awareness, environmental attitudes, and a sense of responsibility toward sustainability. These findings strongly align with child-friendly school principles that prioritize student agency, inclusion, and meaningful participation. However, the literature remains limited in exploring how socio-cultural norms, teacher preparedness, and institutional support structures influence the sustainability of student-led initiatives. Further research is needed to investigate long-term behavioral outcomes and to assess how student participation models function across different cultural and educational contexts.

3.4.3 Eco-Friendly Infrastructure and Design

This cluster centers on the architectural and physical dimensions of sustainability in educational environments, highlighting strategies such as courtyard-based designs that optimize natural lighting and ventilation (Salameh, 2024) and green roofs that support thermal regulation, biodiversity, and stormwater management (Zahedi et al., 2024). Although these studies demonstrate the technical and environmental benefits of sustainable school design, they also point to significant financial and institutional barriers, particularly in low-income regions where initial investment costs and maintenance demands limit adoption. Moreover, research in this cluster tends to prioritize technical performance over pedagogical or child-centered outcomes. Future studies could address this gap by integrating architectural analysis with educational and psychosocial perspectives, examining how eco-friendly infrastructure directly influences student well-being, learning engagement, and inclusivity.

3.4.4 Values, Ethics, and Holistic Approaches

This cluster highlights the role of cultural values, ethical frameworks, and holistic educational philosophies in shaping sustainability education. Context-specific models such as Bhutan's *Sherig Mandala* (Chitra, 2021; Sadagopan, 2025), rooted in Gross National Happiness, and the eco-humanism approach in Israel (Gal, 2023) expand the concept of green schools beyond infrastructure and policy to include moral development, empathy, and environmental ethics. While these approaches offer powerful conceptual insights, they remain underrepresented in large-scale empirical research. The transferability of culturally embedded models across different educational systems also remains insufficiently explored, suggesting a need for cross-cultural and comparative studies that examine how values-based sustainability education can be adapted without losing contextual relevance.

Taken together, the integration of these four thematic clusters reveals a shared objective between child-friendly school management and green school initiatives: the creation of educational environments that are safe, inclusive, and empowering, while fostering students' capacity to act as agents of environmental change. However, the bibliometric patterns also expose gaps in longitudinal evidence, comparative cross-national research, and interdisciplinary integration. Addressing these gaps through sustained, multi-contextual research and responsive policy design is essential for advancing scalable, equitable, and context-sensitive models of child-friendly and environmentally sustainable schools.

Discussion

The findings of this study indicate that, although the green school movement has gained considerable momentum, its systematic integration with child-friendly school management remains

insufficiently explored. Existing research tends to conceptualize green schools primarily in terms of sustainability, infrastructure, and environmental education, while child-friendly schools are more often framed around inclusivity, student-centered learning, participation, and well-being. The central argument emerging from this study is that these two models are inherently complementary. When effectively integrated, they have the potential to simultaneously enhance educational quality and environmental impact (Salazar et al. 2024). Evidence from schools implementing structured environmental certification programs further supports this claim, as such frameworks have been shown to exert a significant positive influence on students' pro-environmental behavior, reinforcing the role of institutionalized sustainability practices in both educational and behavioral transformation (Sulistyarini et al. 2022).

Despite this potential synergy, the literature reveals substantial socio-economic and institutional barriers that limit broader implementation. A pronounced disparity exists between developed and developing contexts in terms of policy support, financial resources, and institutional capacity. Schools in developed countries typically operate within well-established policy environments that provide stable funding, trained personnel, and access to technologies that support sustainability initiatives, including renewable energy systems, waste management infrastructure, and sustainability-oriented curricula. In contrast, schools in developing regions often face persistent financial constraints, limited teacher training in environmental education, and inadequate physical infrastructure, which restrict the adoption and continuity of green school programs (Verma and Grover, 2022). As a result, sustainability efforts in these contexts are frequently fragmented, short-term, or dependent on external support from NGOs and international donors. These findings highlight the need for context-sensitive policy responses, such as targeted funding schemes, capacity-building programs for educators, and flexible sustainability standards that accommodate local socio-economic conditions. Future research should adopt comparative and policy-oriented approaches to examine how such adaptive frameworks can reduce implementation gaps across diverse educational systems.

Beyond resource-related constraints, institutional leadership and governance structures emerge as critical determinants of successful sustainability integration. School leaders who embed sustainability into institutional visions, strategic planning, and daily practices play a pivotal role in ensuring the continuity and depth of green initiatives. Multi-level policy alignment—spanning school, district, and national levels—is often necessary to institutionalize sustainability within school culture and pedagogy. However, as noted by Karaarslan-Semiz and Sund (2025), the literature rarely examines how leadership-driven sustainability initiatives intersect explicitly with child-friendly school principles. In particular, there is limited empirical evidence on how environmental policies influence student well-being, inclusivity, participatory governance, and children's rights within school settings. This represents a significant research gap, calling for integrative studies that analyze leadership, policy, and child-centered outcomes simultaneously.

The study also underscores the importance of social engagement and participatory practices in advancing sustainability goals. Student involvement in environmental initiatives has been shown to foster environmental responsibility, civic awareness, and active learning. Community-based programs—such as waste reduction campaigns, energy conservation projects, and student-led environmental monitoring—are associated with improved student engagement and positive educational outcomes (Meitiyani et al., 2022). These initiatives provide experiential and contextually meaningful learning opportunities that connect classroom instruction with real-world environmental challenges, supporting cognitive engagement, collaborative problem-solving, and a sense of agency. However, bibliometric patterns reveal a notable lack of longitudinal research examining whether these short-term behavioral and attitudinal changes translate into sustained environmental practices beyond the school context.

Moreover, the mechanisms through which sustainability initiatives contribute to measurable academic outcomes remain insufficiently understood. While several studies report positive associations between environmental engagement and student learning, few employ longitudinal or mixed-methods

designs capable of capturing long-term impacts on academic achievement, lifestyle choices, civic participation, or career trajectories. This gap suggests the need for future research that integrates educational psychology, environmental studies, and curriculum research to unpack the complex relationships between environmental education, behavioral development, and scholastic performance.

Therefore, integrating child-friendly school management with green school initiatives requires a holistic and multi-dimensional approach that encompasses curriculum design, infrastructure planning, leadership development, and community engagement. The intersection of these frameworks offers a promising direction for future research to develop integrative models that are both sustainability-oriented and child-centered. Addressing the identified socio-economic, institutional, and methodological gaps through longitudinal, comparative, and interdisciplinary studies is essential for advancing equitable, resilient, and context-responsive educational systems that support students' holistic development and global environmental responsibility.

4. CONCLUSION

Bibliometric evidence shows a steady rise in research on green school initiatives, yet their systematic integration with child-friendly school management remains limited. Existing studies highlight that well-structured sustainability programs positively shape students' pro-environmental behavior, social responsibility, and engagement, although implementation is often constrained by uneven policy support, limited institutional capacity, and resource disparities across different socio-economic and geographic contexts. In response, educators are encouraged to integrate sustainability into child-centered pedagogies that prioritize participation, experiential learning, and student well-being, while policymakers and school leaders should adopt cohesive frameworks that align sustainability goals with child-friendly principles, supported by adequate funding, leadership development, and context-sensitive implementation strategies. Strengthening interdisciplinary collaboration across education, environmental studies, and school design is also essential to address both learning processes and physical environments. Future research should focus on longitudinal studies to evaluate long-term impacts, comparative analyses across diverse contexts to identify scalable approaches, and deeper investigation into the roles of leadership, governance, and community engagement in sustaining inclusive and participatory practices, all of which are crucial for advancing equitable, child-centered, and environmentally responsible education systems.

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