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THE TRANSFORMATIONAL ROLE OF TEACHERS IN ENHANCING STUDENTS' BIODIVERSITY AWARENESS THROUGH ESD: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT
The threat to biodiversity is increasing due to human activities that degrade the environment. In this context, education plays a crucial role in raising awareness among younger generations, particularly through the Education for Sustainable Development (ESD) approach. Teachers, as primary agents of education, hold great potential when acting transformationally by inspiring students to contribute to environmental sustainability. This study aims to systematically examine the transformational role of teachers in enhancing students' awareness of biodiversity within the framework of Education for Sustainable Development (ESD). Employing a systematic literature review, 16 relevant scientific articles were thematically analyzed. The study finds that transformational teachers—as inspirators, environmental project facilitators, ecological value shapers, and reflective agents—play a pivotal role in fostering student awareness and action for biodiversity preservation. This research contributes to the literature by emphasizing the pedagogical and moral dimensions of teaching and offers directions for ESD-based teacher training.
Keywords: transformational, teacher, biodiversity, ESD, environmental awareness

INTRODUCTION
The increasingly complex global environmental crisis has posed a major challenge to life on Earth. One of the most critical issues drawing global attention is biodiversity loss, which is caused by deforestation, land-use change, pollution, and overexploitation of natural resources (Segara, 2015). Biodiversity encompasses all forms of life on Earth—from microorganisms and plants to animals—and their interactions with the environment. It not only represents species and ecosystem richness but also forms the foundation for ecosystem stability, food security, and ecological services essential to human survival. Ironically, amid these ecological threats, students' awareness of biodiversity remains low (Karmana, 2022; Septiandini & Nida, 2025). Human-induced pressures such as deforestation, urbanization, monoculture farming, climate change, and environmental pollution are accelerating species extinction and threatening ecosystem balance at both global and local levels.

As a mega-biodiverse country, Indonesia faces serious threats to its biological resources, including both flora and fauna. Reports cited by Meika & Putra (2021) indicate that even in Adiwiyata schools—which are designed to model environmental education—students often show a low level of environmental concern. This reflects a gap between formal environmental programs and actual student awareness. Reports from WWF and

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LIPI also highlight that many endemic species are endangered due to habitat degradation. Unfortunately, public awareness—especially among the younger generation—about the importance of biodiversity remains low (Karmana, 2022). Thus, systematic efforts are needed to build understanding and environmental concern from an early age. To bridge this gap, an educational approach that touches not only the cognitive domain but also values and attitudes is urgently needed. One of the most promising approaches is the integration of Education for Sustainable Development (ESD) into the learning system.

ESD is an educational approach aimed at equipping future generations with the knowledge, skills, values, and actions required to build a sustainable world. UNESCO (2017) emphasizes that ESD is not merely about information transfer, but about promoting behavioral and mindset shifts toward sustainability. It helps learners understand the relationship between humans and nature, the importance of species, and concrete actions that can be taken to protect them (Septiandini & Nida, 2025).

Since the early 2000s, ESD has been developed as a strategic educational response by UNESCO to address sustainable development issues such as climate change, natural preservation, gender equality, and sustainable consumption. In the context of biodiversity, ESD emphasizes the importance of fostering students' critical understanding of the environment and their role as part of the solution (UNESCO, 2017). This approach not only promotes knowledge transfer but also builds values, decision-making abilities, and action-taking for sustainability (Segara, 2015).

Teachers play a crucial role in implementing ESD effectively. They are not only responsible for delivering content but also for shaping character, inspiring, and guiding students to become environmentally responsible citizens. One relevant leadership approach in this regard is the transformational role of teachers—educators who influence students' behavior through modeling, inspiration, empathy, and intellectual stimulation (Md Zain & Aiyub, 2021). Pedagogically, transformational teachers influence and motivate students through exemplary conduct, empathy, inspirational communication, and by empowering students to become agents of change. They are not just instructors but moral and ecological leaders who foster students' values and actions related to sustainability issues, including biodiversity conservation.

This role is reflected in teachers' ability to create meaningful learning, facilitate outdoor exploration, initiate school conservation projects, and foster students' critical reflection on their role in protecting nature (Meika, 2021; Lumbantobing, 2023). Such teachers help develop a sense of ecological responsibility in students beyond cognitive understanding. This aligns with Bascopé et al. (2019), who argue that effective ESD must be grounded in values, community, and scientific action—and that the teacher's role is central to its implementation.

In practice, however, many teachers still lack a comprehensive understanding of ESD and how it relates to biodiversity issues (Vioreza et al., 2023). Septiandini & Nida (2025) show that while ESD is partially embedded in Merdeka Curriculum textbooks, the approach lacks depth and inspiration. Karmana (2022) also notes that high school students' understanding of ESD is shallow and largely dependent on the teacher's approach. Thus, a shift in teaching paradigm is needed—from conventional models to those based on inspiration, active participation, and real-life action toward environmental issues.

Fajar (2021) and Kurniati (2024) reveal that teachers who act as role models and motivators significantly influence the formation of students' environmental character. Teachers who actively participate in Adiwiyata programs and demonstrate real

environmental concern are more successful in fostering ecological awareness. Meika & Putra (2021) emphasize the importance of experience-based learning and student involvement in school environmental activities.

Most ESD studies still focus on curriculum, learning materials, or policy, and rarely explore the leadership dimension of teachers as transformational actors—especially in biodiversity education. As stated by Md Zain & Aiyub (2021), ESD teacher competencies must include professional, intrapersonal, and sustainability-specific aspects, all of which are necessary for meaningful ESD integration.

However, key challenges remain—especially the lack of pedagogical skills among teachers to integrate ESD into subjects in a contextual manner (Vioreza et al., 2023). Lumbantobing (2023) also notes that many school environmental programs are not integrated with reflective sustainability values, often implemented as formality without participatory or transformative approaches.

Karmana (2022) concluded that models and media used in teaching significantly influence ESD understanding. When teachers adopt contextual and experiential methods—such as environmental projects—students' biodiversity awareness increases significantly. This is supported by Bascopé et al. (2019), who found that project-based, outdoor, and arts-based pedagogies are effective ESD strategies, particularly in early childhood education.

Bascopé et al. also identified three pillars of ESD: science-based, value-based, and community-based. Transformational teachers play a strategic role in bridging these pillars through teaching practice, not only as facilitators of environmental projects but also as community mobilizers and instillers of sustainability values from an early age.

Despite this, ESD studies in Indonesia still focus heavily on curriculum and content, without fully addressing how individual teachers—acting as transformational agents—can influence students' biodiversity awareness (Md Zain & Aiyub, 2021; Septiandini & Nida, 2025). This literature review aims to fill that gap by systematically identifying patterns in the transformational role of teachers within ESD and biodiversity education.

Therefore, it is essential to conduct a systematic literature review focused on how teachers act as transformational agents in raising students' awareness of biodiversity. This study not only enriches the theoretical discourse on teachers' roles in ESD but also offers practical contributions to teacher training, instructional design, and sustainable education policy.

The objectives are to: (1) Identify and classify the transformational roles of teachers in shaping students' biodiversity awareness, (2) Analyze pedagogical approaches used to internalize biodiversity values through ESD, (3) Synthesize empirical findings on best practices that can inform teacher training and education policy.

Using the Systematic Literature Review (SLR) method guided by the ROSES protocol, this study reviewed 16 selected national and international journal articles. The review not only summarizes but also critiques and synthesizes previous findings to build a conceptual framework for strengthening teacher capacity in sustainability education.

This study is expected to provide both theoretical and practical contributions. Theoretically, it reinforces the position of teachers as agents of change in sustainability education. Practically, the findings can serve as a foundation for designing teacher training, instructional modules, and more contextual and participatory environmental education policies.

METHOD

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This study adopts a Systematic Literature Review (SLR) approach, systematically designed to answer the research question regarding the transformational role of teachers in enhancing students' biodiversity awareness within the framework of Education for Sustainable Development (ESD). An SLR enables researchers to review, critically appraise, and synthesise relevant studies to identify patterns, gaps, and best practices in previous literature (Shaffril et al., 2021). The process follows the ROSES (Reporting Standards for Systematic Evidence Syntheses) guidelines to ensure quality and transparency.

Research Question (PICo Framework)

Element	Specification in this study
P – Population	Primary and secondary school teachers and students
I – Interest	Transformational teacher roles in classroom practice
Co – Context	Education for Sustainable Development with an emphasis on biodiversity

Table 1. PICo Framwork

Main research question: How can transformational teachers enhance students' biodiversity awareness in the context of ESD, according to the existing literature?

Literature Search Strategy

Searches were conducted in four major databases—Scopus, ScienceDirect, Google Scholar, and DOAJ—using Boolean-based keywords:
("transformational teacher" OR "transformational pedagogy" OR "teacher leadership") AND ("biodiversity education" OR "environmental awareness" OR "ESD") AND ("student engagement" OR "environmental education")

The time span was limited to 2015–2025, reflecting the decisive decade following the 2030 Agenda for Sustainable Development (UNESCO, 2017). To ensure Indonesian relevance, accredited national journals covering Adiwiyata practice (Fajar, 2021), environmental character education (Meika & Putra, 2021), and Merdeka Curriculum implementation (Vioreza et al., 2023) were also consulted.

Inclusion and Exclusion Criteria

Inclusion criteria such as peer-reviewed studies (reputable national and international journals), published between 2015 and 2025, focus on teacher roles, ESD, or environmental education, address students' biodiversity awareness or understanding, empirical studies (quantitative/qualitative) or relevant literature reviews, and written in English or Indonesian. While exclusion criteria such as no full-text access, curriculum-only papers with no discussion of teacher roles, higher-education studies unrelated to primary/secondary contexts and descriptive papers lacking empirical data or thematic synthesis

Screening Process

The initial search produced 208 articles. Title–abstract screening reduced this to 88 potential papers. Full-text review yielded 16 final articles meeting all criteria. Some gave micro-level insights (teacher–student interactions) while others offered macro perspectives (educational approaches and ESD policy). For example, Karmana (2022) reviewed ESD understanding among high-school students, whereas Md Zain & Aiyub (2021) systematically assessed teacher competencies.

Data Analysis

A thematic analysis was conducted: (1) Open Coding – Key phrases related to teacher roles, transformational practices, and biodiversity awareness were identified, (2) Axial Coding – Codes were clustered into themes such as teachers as inspirators, facilitators, ecological value reflectors, and project drivers (Bascopé et al., 2019; Meika & Putra, 2021), (3) Selective Coding – A final narrative synthesis highlighted effective interventions and prevailing challenges.

Validation and Bias Control

Validation and Bias Control can be done by each article was reviewed twice to avoid selection bias, coding data and thematic summaries were logged in a shared spreadsheet, findings were cross-checked against UNESCO's (2017) ESD framework and the meta-analysis by Bascopé et al. (2019), coding considered geographic spread, educational level, and local Indonesian relevance.

Ethical Considerations

As a literature study, no human subjects were directly involved. All sources were peer-reviewed publications, cited in accordance with academic ethics.

Outcome

Through this ROSES-based SLR, the study distilled and analysed the most relevant evidence to answer the research question. Thematic analysis identified recurring patterns and best practices that can serve as references for strengthening transformational teacher roles in biodiversity education. The results open new avenues for classroom action research, teacher professional development, and the design of biodiversity-based ESD models in Indonesia.

RESULTS AND DISCUSSION

The synthesis of 16 articles through a systematic literature review revealed that the transformational role of teachers in enhancing students' biodiversity awareness through the Education for Sustainable Development (ESD) approach can be classified into four major themes: 1) teachers as ecological inspirators and role models, 2) teachers as facilitators of project- and value-based learning, 3) teachers as builders of reflection and ecological awareness, and 4) implementation challenges of sustainability pedagogy in schools. These themes are interrelated and form a conceptual framework for the transformational role of teachers in biodiversity-based ESD.

Teachers as Ecological Inspirators and Role Models

Teachers play a key role in shaping students' environmental values by becoming daily role models. Transformational teachers do not only deliver biodiversity concepts cognitively, but also demonstrate consistent pro-environmental behavior. These behaviors include using tumblers, sorting waste, and engaging in school greening. Fajar (2021) found that in Adiwiyata schools, teachers significantly influence students by modeling behaviors such as keeping the school clean, planting trees, and guiding waste sorting. Teachers who demonstrate a strong commitment to the environment have been shown to be more effective in shaping students' environmental character. Kurniati (2024) confirmed that everyday actions such as bringing reusable bottles or refusing to litter

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contribute positively to students' behavioral change. Fajar (2021) and Kurniati (2024) assert that teacher role modeling directly enhances students' environmental awareness through the internalization of values. In the context of Adiwiyata schools, teachers who consistently demonstrate environmentally friendly lifestyles are more successful in encouraging students to actively engage in conservation activities.

Meika & Putra (2021) emphasized that teachers act as role models in building students' ecological character through habitual clean-up actions, waste management, and garden maintenance. Transformational teachers also build emotional connections with students and encourage real action—like participating in school gardening or city park cleanups—which strengthen students' attachment to nature. This modeling aligns with UNESCO (2017), which argues that sustainability values are more effectively instilled through real-life modeling than normative instruction.

Lumbantobing (2023) also noted that teachers leading school waste-free programs help foster collective ecological responsibility among students by actively engaging in conservation efforts.

Teachers as Facilitators of Contextual and Participatory Learning

Transformational teachers excel in designing project-based, place-based, and community-collaborative learning experiences. This aligns with ESD principles that emphasize active, experiential, and locally relevant learning (UNESCO, 2017; Segara, 2015).

Vioreza et al. (2023) stated that the Merdeka Curriculum allows space for interdisciplinary, sustainability-oriented projects, but successful implementation depends on teacher initiative. Transformational teachers seize these opportunities by integrating biodiversity into lessons through school greening projects, tree adoption, or species inventory activities. However, the curriculum offers flexibility without technical guidelines, leaving much to the creativity of individual teachers.

Bascopé et al. (2019) highlighted the value of outdoor and arts-based learning, especially in early childhood education, for fostering environmental empathy. Creative and reflective teachers design meaningful learning such as ecosystem mapping and recycled art installations. This approach has proven effective in fostering environmental concern from an early age. Studies on ESD in early childhood education have identified project-based and outdoor learning as effective strategies for instilling sustainability values, including biodiversity. Teachers play a central role in designing meaningful learning experiences that connect directly with students' natural surroundings.

In primary and secondary levels, Lumbantobing (2023) described teachers facilitating waste-free classroom projects and engaging local communities, acting as bridges between students, schools, and their environments.

Septiandini & Nida (2025) emphasized that while science content in the Merdeka Curriculum has ESD potential, it is teachers who must contextualize the content, making biodiversity locally relevant, exploratory, and action-driven.

Teachers as Builders of Reflection and Ecological Awareness

Transformational teachers do more than teach content; they shape how students think about human-nature relationships. They promote reflection, value-based discussions, and critical environmental thinking.

Md Zain & Aiyub (2021) proposed that teachers with strong intrapersonal and moral competencies can guide students to reflect on how human actions affect

biodiversity.
This requires teachers to internalize sustainability values before teaching them.

Segara (2015) highlighted that ESD must be grounded in interdisciplinary and value-dialogue approaches. Teachers should guide students in discussing real-world cases like deforestation, species extinction, or coral reef degradation, and relate these to everyday choices and actions. The development of sustainability values cannot be achieved through one-way lectures alone, but rather through social reflection and value-based discussions guided by the teacher.

Karmana (2022) found that high school students gained a deeper understanding of biodiversity when teachers used reflective discussions and narratives, rather than traditional lectures. Students became more sensitive and aware of biodiversity issues when encouraged to reflect and make value-based decisions in biology classes. This means that teachers who are able to connect biodiversity content with real-life experiences and life values are more effective in fostering students' ecological awareness.

Challenges in Implementing Transformational Pedagogy for ESD

Despite their importance, transformational roles face significant challenges in practice. Teachers are often constrained by limited time, resources, training, and institutional support.

While the Merdeka Curriculum encourages innovation, many teachers lack the competence and training to integrate ESD and biodiversity into class projects. Vioreza et al. (2023) noted that many teachers struggle to apply ESD across disciplines due to low sustainability literacy.

Septiandini & Nida (2025) pointed out that primary school science textbooks often lack strong or explicit ESD and local biodiversity content. Teachers without proper training find it difficult to adapt curriculum meaningfully.

Fajar (2021) and Meika & Putra (2021) highlighted structural issues—insufficient facilities, lack of school-wide ESD culture, limited principal support, and administrative burdens—that hinder teacher innovation. Environmental programs like Adiwiyata often remain symbolic, detached from classroom learning.

Lumbantobing (2023) added that some teachers resist participatory or project-based methods, preferring lectures due to time and workload concerns.

Thematic Synthesis and Practical-Theoretical Implications

From these themes, the transformational role of teachers in biodiversity-based ESD involves: (1) personal inspiration and ecological role modeling, (2) facilitation of active and contextual learning, (3) development of reflective, value-based student thinking, (4) pedagogical innovation and adaptation amid systemic limitations. This role integrates four dimensions: (1) Personal and moral values: ecological commitment and modeling, (2) pedagogical capacity: designing participatory, contextual learning, (3) reflective leadership: guiding value formation and critical thinking, (4) institutional support: policies and environments that empower teacher initiatives.

These findings reinforce UNESCO's (2017) ESD framework, which requires synergy across cognitive, social-emotional, and behavioral domains. Teachers are not merely content transmitters but transformative agents influencing how students think, feel, and act.

Practically, this study recommends that teacher training emphasize not only content mastery but also ecological leadership, reflective pedagogy, and daily

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modeling.Training modules should prepare teachers to facilitate projects, lead discussions, and embody sustainable behaviors.

The literature indicates that the transformational role of teachers in promoting biodiversity awareness among students is highly significant and multidimensional. Teachers can serve as inspirators, facilitators, value educators, and agents of change, shaping students' environmental consciousness holistically. However, without systemic support and adequate training, this potential is difficult to fully realize.

For policymakers, these findings suggest that teacher training programs must be expanded to include not only content mastery but also value development, moral leadership, and reflective capability. Schools must also create an ecosystem that supports biodiversity-based ESD practices.

This section highlights that transformational teachers play a crucial role in shaping students' awareness of biodiversity—not only through content delivery, but through modeling, facilitating ecological learning, and cultivating sustainability values. Nevertheless, the realization of this role continues to face multiple challenges that must be addressed through systemic change.

Theoretical and Practical Contributions

Theoretically, this study reinforces the position of teachers as agents of change within the framework of Education for Sustainable Development (ESD), particularly in fostering students' awareness of biodiversity. The findings support the UNESCO (2017) framework which states that effective sustainability education requires a holistic approach encompassing cognitive, affective, and conative dimensions. Transformational teachers are not only facilitators of learning but also role models and moral leaders who shape students' perspectives and actions toward the environment holistically. Therefore, this study strengthens the literature that advocates educational transformation must begin with the central actor in the classroom: the teacher.

Practically, this study offers concrete direction for developing teacher capacity in biodiversity-based ESD. Teacher training should not solely focus on content delivery but also on building reflective competencies, ecological leadership, and the ability to design project-based and locality-based learning. Teachers must be equipped to connect biodiversity issues with students' life contexts, facilitate value-based discussions, and create memorable and meaningful learning experiences. Moreover, pre-service teacher education models must be redesigned to cultivate ecopedagogical character, environmental empathy, and social sensitivity. This study suggests that teacher training programs should incorporate: (1) development of biodiversity-based project learning rooted in local context, (2) reflective and collaborative approaches to internalizing sustainability values, (3) strategies to facilitate students' ecological initiatives, and 4) modeling of pro-environmental behavior in daily life.

The teacher education curriculum must therefore be restructured to go beyond content and technical pedagogy by fostering ecological character, moral leadership, and environmental empathy among future teachers.

Policy Implications and Future Research Directions

This study provides a strong foundation for formulating teacher-based sustainable education policies. The first policy implication is the need to reform teacher education and training programs—such as PPG, tiered training, and Adiwiyata programs—to incorporate transformational elements and ecopedagogical approaches. Training modules

should focus on developing teachers' ability to facilitate reflective, contextual learning rooted in local biodiversity issues. This aligns with the findings of Md Zain & Aiyub (2021) and Bascopé et al. (2019), who emphasized the importance of value-based and intrapersonal competencies in ESD.

The second policy implication is the provision of formal recognition and incentives for teachers actively involved in sustainability education initiatives. As highlighted by Lumbantobing (2023) and Fajar (2021), institutional support is critical for the continuity of teacher initiatives. Therefore, performance-based ecological incentives must be developed by educational institutions and local governments.

The third policy implication is the integration of contextual curricula based on local biodiversity. Learning materials and school projects should be designed to connect students with their region's biological richness (Septiandini & Nida, 2025), making learning more meaningful and relevant.

Recommended future research directions include action research that documents real practices of transformational teachers in schools. In addition, longitudinal studies are needed to trace the long-term impact of ESD interventions on students' ecological behavior. Expanding research into practical and policy domains will help establish an educational ecosystem that consistently supports sustainability values

Teacher Training Recommendations for Strengthening the Transformational Role in ESD and Biodiversity

Based on the findings of this study, teachers play a central role as transformational agents in raising students' awareness of biodiversity through the Education for Sustainable Development (ESD) approach. However, the implementation of this role depends heavily on teachers' capacities in values, pedagogy, reflection, and systemic support. Therefore, a comprehensive and transformative teacher training model is urgently needed. The following are six recommended forms of training:

Ecopedagogy training based on values and reflection to equip teachers with the ability to internalize sustainability values before instilling them in students. Intrapersonal and moral competencies, as outlined by Md Zain & Aiyub (2021), are the foundation. Activities may include eco-retreats, case study discussions on environmental crises (e.g., deforestation, species extinction), and personal ecological narratives.

This training is essential for developing an *ecological self*, which forms the basis of moral leadership and exemplary behavior (Fajar, 2021; Kurniati, 2024). Teachers who demonstrate consistent pro-environmental behavior serve as effective role models for shaping students' environmental character (Meika & Putra, 2021).

Training in contextual and project-based learning design is a learning transformation occurs only when teachers have the capacity to design exploratory and applicable instruction. Vioreza et al. (2023) emphasized that the Merdeka Curriculum provides ample space for integrating ESD into interdisciplinary projects. However, without proper technical training, teachers may struggle to implement it.

This training covers how to integrate local biodiversity into project-based learning, develop thematic lesson plans (RPP), and implement school projects such as tree adoption, species inventories, or recycling programs. Septiandini & Nida (2025) stress the importance of teachers translating science content into contextual experiences that touch students' daily lives.

Outdoor learning and interdisciplinary teaching training, Bascopé et al. (2019) demonstrated that outdoor and arts-based learning is highly effective in instilling

sustainability values from an early age. Thus, teachers should be trained to use their surroundings as learning environments.

This training includes exploring local ecosystems, mapping school biodiversity, using recycled materials in educational art projects, and developing interdisciplinary lesson plans that integrate science, social studies, and language arts with ecological themes. This approach strengthens students' connection with nature.

Training on facilitating value dialogues and student reflection is a value transformation does not occur through lectures alone but through dialogue and reflection. Segara (2015) and Karmana (2022) highlighted that critical storytelling, reflection, and value-based discussion are effective in fostering student awareness of sustainability issues.

This training prepares teachers to use facilitation techniques such as value clarification, Socratic questioning, ecology-based storytelling, and environmental journaling. Teachers will learn to create safe spaces for students to reflect and make sustainability-driven decisions.

Digitalization and documentation of esd practices to ensure that good practices go beyond the classroom, teachers need skills to document and disseminate their innovations. This training includes the use of social media, learning blogs, and learning management systems (LMS) to showcase student projects, build digital ESD portfolios, and archive biodiversity-related learning activities.

Effective documentation helps position teachers' work as national references and opens opportunities for inter-school collaboration. This also nurtures a sharing and learning ecosystem.

Sustainable school leadership training because transforming a school cannot be accomplished by individual teachers alone. This training is designed for senior teachers or environmental program coordinators to manage initiatives such as Adiwiyata in a more integrated and non-administrative manner (Fajar, 2021; Lumbantobing, 2023).

Training topics include change management, multi-stakeholder collaboration (with environmental agencies, NGOs, or parents), and ecological policy advocacy at the school level. The goal is to build a school culture that supports transformational practices systemically.

These training programs should be implemented continuously and adapted to educational levels, regional characteristics, and teachers' initial capacities. Government institutions and training providers such as Pusdiklat GTK, LPMP, and PPG programs must incorporate biodiversity-based ESD as a core element, not just as supplementary material.

With training that addresses values, pedagogy, reflection, and systems, teachers will not only act as curriculum implementers but as transformational agents in shaping a generation that is environmentally aware, responsible, and committed to sustainability.

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CONCLUSION

This study aims to systematically examine the transformational role of teachers in enhancing students' awareness of biodiversity within the framework of Education for Sustainable Development (ESD). Through the analysis of 16 national and international journal articles, this research presents a comprehensive thematic mapping of teacher contributions in shaping students' ecological awareness, particularly in relation to biodiversity issues.

The findings indicate that transformational teachers do not only function as transmitters of knowledge, but also as agents of change in values, behavior, and environmental awareness. This role is realized through four key dimensions: (1) modeling and inspiration, (2) facilitation of project-based ecological learning, (3) cultivation of reflection and ecological values, and (4) adaptation to structural challenges in education.

First, the study affirms that teachers serve as catalysts in developing students' ecological awareness. As shown by Fajar (2021) and Kurniati (2024), teachers who serve as role models through daily actions—such as maintaining school cleanliness, avoiding single-use plastics, or tending school gardens—implicitly instill environmental care values in their students.

Second, transformational teachers contribute by facilitating experiential learning that is local, participatory, and integrated. Vioreza et al. (2023) note that the Merdeka Curriculum opens opportunities to integrate ESD through Pancasila student profile projects, though the teacher's role in designing and implementing them is pivotal to success.

Third, teachers play a role in cultivating student reflection and ecological value formation. Md Zain & Aiyub (2021) argue that teachers' sustainability competence—including intrapersonal and moral dimensions—is fundamental to delivering ESD in a transformative way. Teachers not only guide outdoor activities but also shape students' perspectives on human-nature relationships.

Despite its great potential, implementing the transformational role of teachers in ESD faces challenges. Vioreza et al. (2023) reveal that many teachers have not received adequate training on how to apply ESD principles and biodiversity topics in classroom practice. Many perceive ESD as an additional burden, not as an integral part of the education process.

However, realizing this role requires systemic support in the form of training, policy, school culture, and a responsive curriculum that addresses 21st-century environmental challenges. Moving forward, teachers must not only be skilled instructors but also capable leaders of change in building a sustainable future. Thus, this study not only reinforces the theoretical foundation of the teacher's role in ESD but also provides concrete directions for the implementation and development of sustainability education in Indonesia and across the Global South.

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