

INTEGRATION OF EDUCATION FOR SUSTAINABLE DEVELOPMENT INTO SECONDARY SCHOOL CURRICULA: A REVIEW OF PEDAGOGICAL APPROACHES, TEACHER PREPAREDNESS, STUDENT ENVIRONMENTAL AWARENESS, BEHAVIORAL CHANGE OUTCOMES, AND CROSS-NATIONAL POLICY FRAMEWORKS

Aghosh Riaz^{*1}, Syeda Adina Gardezi², Muhammad Irfan Haider³

^{*1,2}Department of Educational Sciences, National University of Modern Languages, Islamabad, Pakistan

³Lecturer (Urdu), Government Graduate College Jauharabad, Khushab, Pakistan

¹aghoshriaz12@gmail.com, ²adinasyed09@gmail.com, ³Irfanhaider1004@gmail.com

Corresponding Author: *

Aghosh Riaz

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ABSTRACT

The growing global concerns about climate change, environmental sustainability, and sustainable social development have made Education for Sustainable Development (ESD) a crucial part of secondary school curriculum reform. With a focus on pedagogical strategies, teacher readiness, student environmental awareness, behavioural change outcomes, and cross-national policy frameworks, this systematic review investigated the incorporation of ESD into secondary school curricula. 45 studies published between 2015 and 2025 that were gathered from databases such as Scopus, ERIC, Springer, Taylor & Francis, Frontiers, MDPI, and Google Scholar were examined using the PRISMA framework. The results showed that 55.6% of the chosen papers were published between 2021 and 2025, demonstrating a sharp increase in sustainability education research after the Sustainable Development Goals (SDGs) were put into effect. The two regions that produced the most studies were Asia (35.6%) and Europe (28.9%). The most popular ESD strategy was multidisciplinary curricular integration (40.0%), which was followed by project-based learning (24.4%). To improve experiential learning and sustainability competencies, participatory and transformative pedagogies, such as community-based initiatives (28.9%) and outdoor learning (26.7%), were commonly used. Continuous professional development was shown to be the key tactic for enhancing sustainability teaching methods in 40% of the studies, indicating that teacher readiness continued to be a crucial element impacting ESD adoption. The review also demonstrated that ESD improved students' civic involvement, recycling habits, waste reduction strategies, environmental knowledge, and climate literacy. The most significant worldwide policy frameworks directing curriculum improvements for sustainability have been identified as SDG 4.7 and UNESCO initiatives. Effective ESD integration was however hampered by implementation issues such as scarce resources, inadequate monitoring systems, and uneven regional support. Overall, the study shows that ESD considerably raises secondary school students' awareness of sustainability and encourages pro-environmental behaviour. It also emphasizes the necessity of greater institutional support, interdisciplinary curriculum changes, and sustained policy commitment for successful sustainability education.

Keywords: Behavioral Change, policy frame work, sustainability education, teacher preparedness, interdisciplinary learning, participatory pedagogies, sustainability literacy, curriculum integration

Introduction

Secondary education represents a particularly important stage for the integration of Education for Sustainable Development (ESD), as it shapes adolescents' environmental awareness, critical thinking abilities, civic responsibility, and long-term sustainability-related behaviors (Colegado & Colegado, 2026). In recent decades, education systems worldwide have increasingly incorporated sustainability into secondary school curricula in response to global environmental, social, and economic challenges as well as international policy agendas promoted by organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations (UN). Education, particularly curricular reforms, has accelerated in the past two to three decades in response to global education policy goals on sustainability (Monika, 2024).

Educational research increasingly emphasizes that the successful integration of ESD into school curricula depends not only on policy inclusion but also on effective pedagogical implementation, teacher preparedness, and student engagement. Previous studies indicate that interdisciplinary and participatory teaching approaches, including project-based learning, inquiry-based instruction, experiential learning, collaborative learning, and community centered activities, play a critical role in promoting sustainability competencies among secondary school students (Hung & Pan, 2025).

Similarly, teacher training, institutional support, curriculum flexibility, and access to pedagogical resources significantly influence the effectiveness of ESD implementation in classrooms. Research further suggests that well-designed ESD programs can enhance students' environmental awareness, sustainability literacy, critical thinking, problem-solving abilities, and pro-environmental behavioral outcomes (McPhail, 2022).

Against this backdrop, the present review aims to examine the integration of education for sustainable development into secondary school curricula from multiple educational and policy perspectives. Specifically, the review focuses on

pedagogical approaches used in ESD implementation, teacher preparedness for sustainability education, student environmental awareness and behavioral change outcomes, and cross-national curriculum policy frameworks related to sustainability education. The study further examines how sustainability and ESD are conceptualized at both the transnational and national levels, where sustainability is promoted as a global educational priority and integrated into curriculum reforms across different educational systems.

Correspondingly, the review addresses the following key research questions:

1. How is education for sustainable development integrated into secondary school curricula across different national contexts?
2. What pedagogical approaches are most commonly used in ESD implementation at the secondary school level?
3. How does teacher preparedness influence the effectiveness of ESD integration?
4. What impacts does ESD have on students' environmental awareness and sustainability-related behavioral outcomes?
5. How do cross-national curriculum policy frameworks shape the implementation of ESD in secondary education?

The national contexts of England, India, Norway, and Pakistan are examined as case illustrations of how countries with differing geographic, sociocultural, economic, political, and educational contexts adapt their curricula to emphasize sustainability within a broader global movement toward sustainable development (Khan et al., 2025). This review is distinctive because it combines curriculum policy analysis with examination of pedagogical implementation and student-level educational outcomes, thereby providing a more comprehensive understanding of ESD integration within secondary education systems.

Curriculum Integration, Pedagogical Approaches, and Education for Sustainable Development

Many countries have started to develop policies and guidelines to promote sustainability education and education for sustainable development, with growing interest in incorporating sustainability into formal school curricula (Bagoly Simó, 2023; Nguyen et al., 2024). Comparative analyses across multiple national contexts demonstrate both the widespread adoption of ESD and considerable variation in how sustainability is framed, implemented, and assessed within educational systems (Balinggan, 2023; Fernández Palacio, 2025; Fischer et al., 2022)

Scholars increasingly advocate transformative, participatory, interdisciplinary, and action-oriented pedagogies that move beyond theoretical knowledge toward practical sustainability competencies. Such approaches emphasize experiential learning, inquiry-based activities, collaborative problem solving, critical reflection, and civic engagement to help students develop the knowledge, attitudes, values, and behaviors necessary for sustainable living (Hunter, 2023; Tilak et al., 2026).

Additionally, studies show that when ESD is applied successfully, it can have a favourable impact on students' ethical reasoning, sustainability literacy, environmental awareness, and pro-environmental actions. Nonetheless, the degree of these results differs significantly between educational settings, instructional approaches, and legislative frameworks (Zhang & Cao, 2025). The study also looks at how curriculum ideologies influence the incorporation of ESD into secondary school and how international sustainability agendas are modified within various educational systems.

The goal of the current study was to methodically investigate how Education for Sustainable Development (ESD) is incorporated into secondary school curricula in various educational and national contexts. The study specifically aimed to analyze the pedagogical strategies employed in sustainability education, evaluate the contribution of professional development and

teacher readiness to the successful implementation of ESD, and examine the effects of sustainability education on students' environmental awareness and behavioural change outcomes. The review also sought to understand how international sustainability agendas impact curricular reforms and educational practices by analyzing cross-national policy frameworks, such as SDG 4.7 and UNESCO initiatives. The study also aimed to uncover institutional hurdles, implementation issues, and new trends related to ESD integration in secondary education systems across the globe.

Methodology

Research Design

This study employed a systematic literature review methodology to investigate the integration of Education for Sustainable Development (ESD) into secondary school curricula, focusing on pedagogical approaches, teacher preparedness, student environmental awareness, behavioral change outcomes, and cross-national policy frameworks. A systematic review approach was selected because it enables the comprehensive collection, evaluation, and synthesis of findings from diverse educational contexts and policy environments. The study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure methodological transparency, consistency, and reliability throughout the review process.

Search Strategy and Data Sources

The review focused on literature published between 2015 and 2025 to capture recent developments in sustainability education and curriculum integration. Relevant studies were identified through structured searches across major academic databases, including ERIC, Scopus, Springer, Taylor & Francis, Frontiers, MDPI, and Google Scholar. In addition, institutional repositories and international organization databases such as UNESCO, OECD, UNEP, and the United Nations Sustainable Development Goals (SDGs) portal were consulted to include policy reports, curriculum frameworks, and sustainability

education guidelines. "Education for Sustainable Development," "ESD integration in secondary schools," "sustainability curriculum," "teacher preparedness," "environmental awareness," "behavioral change, and "cross national sustainability policies" were among the search phrases used. To increase the sensitivity and specificity of the search, Boolean operators and keyword combinations were employed.

Inclusion and Exclusion Criteria

To ensure methodological rigor, explicit inclusion and exclusion criteria were applied during the selection process. Studies were included if they were published in English between 2015 and 2025, focused on Education for Sustainable Development or sustainability education within secondary school settings, and addressed at least one of the following themes: pedagogical approaches, teacher preparedness, environmental awareness, behavioral outcomes, or sustainability policy frameworks. Quantitative, qualitative, mixed-methods studies, systematic reviews, and official policy documents were considered eligible for inclusion. Studies focusing exclusively on higher education or informal educational settings, advocacy papers lacking methodological rigor, opinion articles, and duplicate publications were excluded from the review.

Screening and Selection Process

The screening and selection process followed the PRISMA protocol. Initially, all identified records from databases and institutional sources were compiled, and duplicate studies were removed. Titles and abstracts were then screened to determine relevance to the objectives of the study. Studies that met the preliminary criteria underwent full-text review to assess their methodological quality and relevance to ESD integration into secondary education. During this stage, studies lacking empirical evidence, methodological clarity, or direct relevance to the research topic were excluded. The final selection included empirical studies, curriculum implementation research, teacher professional

development studies, and international policy frameworks related to sustainability education.

Data Extraction and Analysis

To ensure uniformity across all chosen research, data extraction was carried out using a standardized framework. Author and publication year, country or region, research objectives, methodology, sample characteristics, pedagogical approaches, teacher training programs, environmental awareness outcomes, behavioral change indicators, and policy integration strategies were all taken from each study. Comparative analysis across various educational systems and national settings was made easier by this methodical extraction technique.

A narrative thematic synthesis approach was used to examine the gathered data. The literature was categorized into broad themes, such as cross-national policy alignment, student environmental awareness, teacher preparation and professional development, pedagogical approaches in ESD, and behavioral change outcomes. The identification of recurrent patterns, similarities, and variations between studies was made possible by this thematic analysis. To assess how well educational practices align with global sustainability goals, findings from empirical studies were triangulated with international frameworks for sustainability education, such as SDG 4.7, UNESCO's Education for Sustainable Development initiatives, and OECD sustainability literacy programs.

Theoretical Framework

The study was guided by Transformative Learning Theory, Social Constructivism, and Action Competence Theory. These theoretical perspectives emphasize experiential learning, critical reflection, collaborative knowledge construction, and learner empowerment in addressing sustainability challenges. Previous studies have highlighted that participatory, interdisciplinary, and context-based pedagogical approaches are particularly effective in promoting sustainability awareness and pro-environmental behavior among students. These frameworks therefore provided a suitable conceptual basis for

analysing the effectiveness of ESD integration into secondary school curricula.

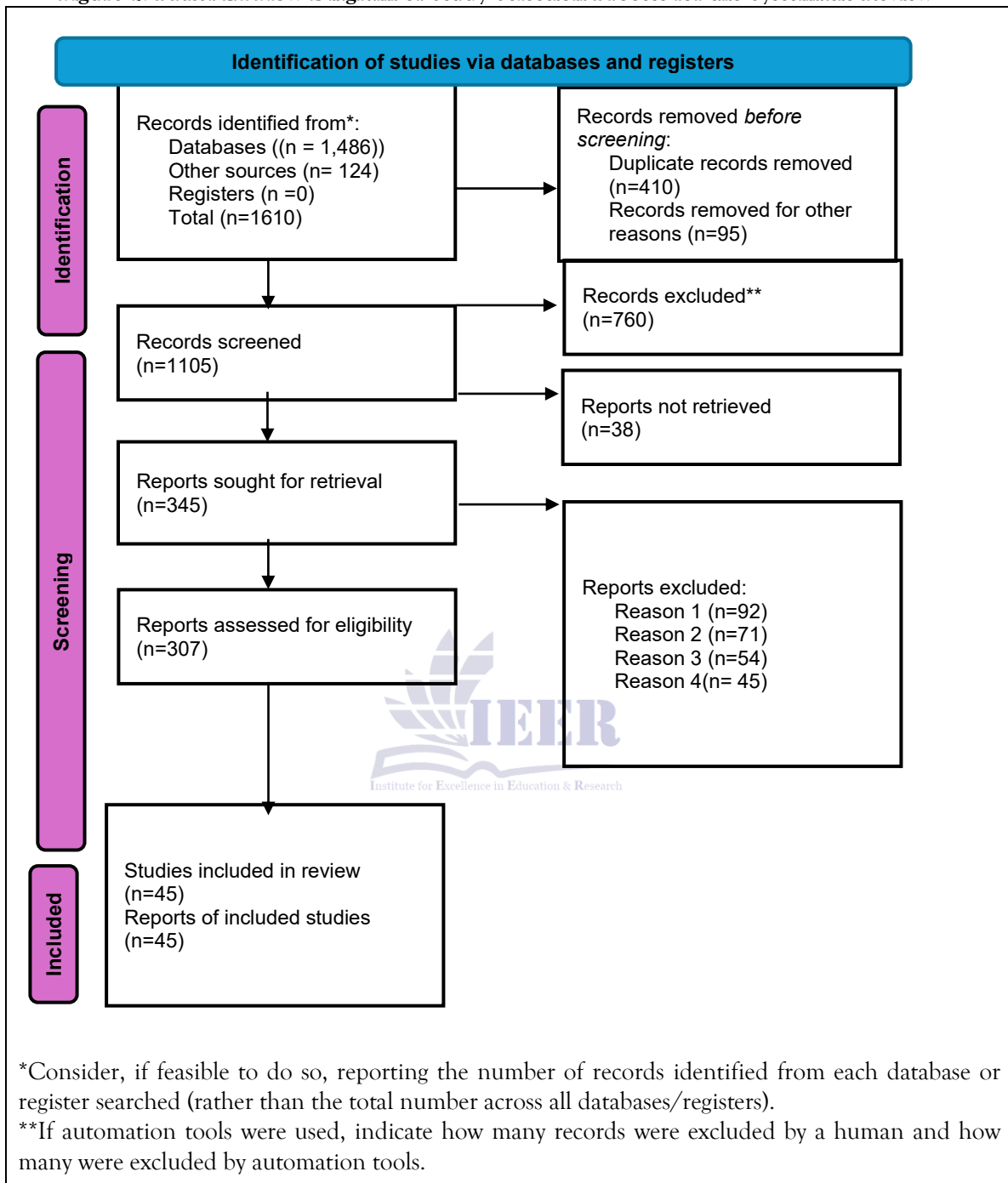
Reliability, validity, and ethical considerations

To ensure reliability and validity, the review adopted transparent search procedures, standardized inclusion and exclusion criteria, and systematic data extraction methods. Triangulation of empirical findings with policy documents and curriculum frameworks enhanced the credibility and trustworthiness of the review.

The use of the PRISMA framework further minimized selection bias and improved methodological transparency. Since the study relied entirely on secondary data and publicly available literature, no direct involvement of human participants was needed. Ethical considerations were addressed by properly acknowledging and citing all original authors, studies, and institutional reports used in the review (Figure 1).



Figure 1: PRISMA Flow Diagram of Study Selection Process for the Systematic Review



Results

Overview of Selected Studies

The findings presented in table 1 indicate that the majority of studies (55.6%) were published between 2021 and 2025, demonstrating a rapid increase in research related to education for sustainable development in recent years. Only 13.3% of the studies were published between

2015 and 2017, showing that sustainability education research expanded significantly after the global adoption of the SDGs.

In terms of geographical distribution, Asia contributed the highest proportion of studies (35.6%), followed by Europe (28.9%). Africa, North America, Oceania, and South America contributed comparatively fewer studies. The

dominance of Asian and European studies suggests that these regions have shown greater institutional and policy interest in integrating sustainability concepts into secondary education curricula.

Regarding research methodologies, qualitative studies represented the largest category (37.8%), followed by quantitative studies (22.2%) and mixed-methods research (20.0%). This indicates that many researchers have emphasized exploring teachers' experiences, curriculum implementation processes, and student perceptions through interviews, observations, and case studies. Policy reports and systematic reviews also contributed important insights into national and international sustainability education frameworks.

The educational contexts showed that public secondary schools were the most commonly investigated setting, accounting for 46.7% of the selected studies. This reflects the central role of public education systems in implementing ESD initiatives. Smaller proportions of studies focused on private schools, international schools, teacher education programs, and community-based sustainability initiatives. Overall, the findings demonstrate the increasing international recognition of sustainability education as an essential component of curriculum reform and educational transformation. Overall, the results

show that sustainability education is becoming more widely acknowledged as a crucial part of curriculum reform and educational transformation on a global scale (Table 1).

Curriculum integration approaches

With 40.0% of the chosen studies, figure 1 demonstrates that the most popular method for integrating education for sustainable development into secondary school curricula was integration across various courses. To give students an integrative grasp of environmental and societal challenges, sustainability themes were primarily incorporated into courses such as science, geography, and social studies.

A total of 24.4% of the studies included project-based curricular integration, which included environmental campaigns, sustainability initiatives, and hands-on classroom activities that encouraged student involvement. A total of 20.0% of subjects were stand-alone sustainability courses, suggesting that certain school systems implemented distinct environmental or sustainability courses. Eco-clubs, recycling initiatives, and tree planting campaigns were among the extracurricular sustainability activities that made up 15.6% of the total. The results indicate that for successful ESD implementation, schools are increasingly favouring integrated and participatory curriculum approaches (Figure 1).

Table 1: Distribution of Selected Studies

Category	Frequency (f)	Percentage (%)
Publication Years		
2015–2017	6	13.3
2018–2020	14	31.1
2021–2025	25	55.6
Total	45	100
Region/Country Distribution		
Asia	16	35.6
Europe	13	28.9
Africa	6	13.3
North America	5	11.1
Oceania	3	6.7
South America	2	4.4
Total	45	100

Types of Studies		
Quantitative	10	22.2
Qualitative	17	37.8
Mixed-Methods	9	20.0
Policy Reports	5	11.1
Systematic Reviews	4	8.9
Total	45	100
Educational Contexts		
Public Secondary Schools	21	46.7
Private Secondary Schools	7	15.6
International Schools	5	11.1
Teacher Education Programs	6	13.3
Community-Based Programs	6	13.3
Total	45	100

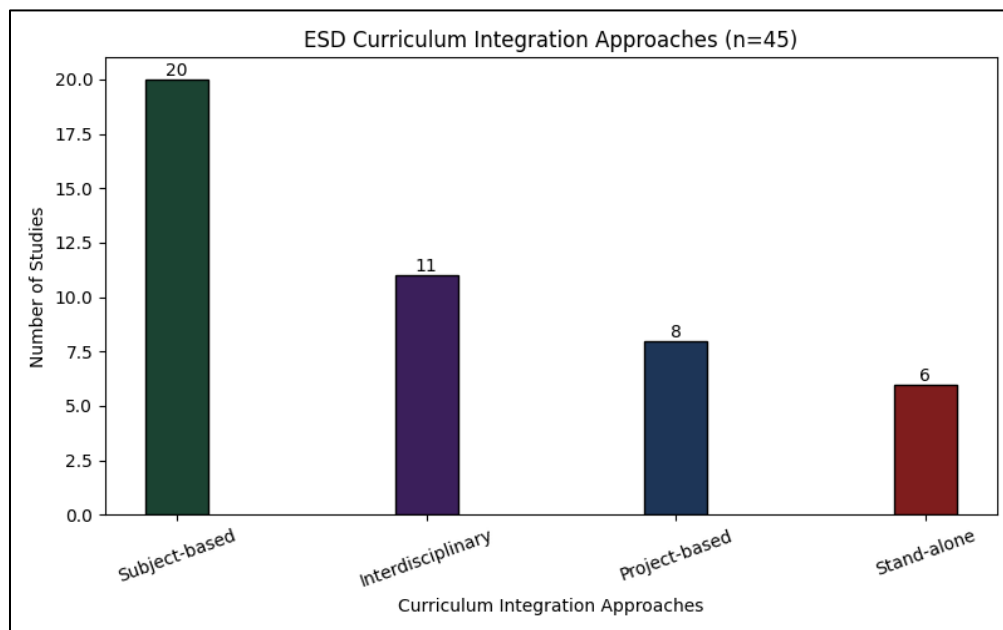


Figure 1: Curriculum Integration Approaches Used in Secondary School Curricula

Key Sustainability Themes Included in Curricula

Figure 4.2 presents the Lorenz Curve illustrating the distribution of sustainability themes across the selected studies. The blue Lorenz curve lies below the equality line, indicating that sustainability themes were not distributed equally among the reviewed studies. Some themes received considerably greater emphasis than others within secondary school sustainability education research.

The curve shows that a smaller proportion of themes accounted for a relatively lower cumulative share of studies during the initial stages of the graph. As the cumulative share of themes increased, the cumulative share of studies also increased gradually before reaching complete equality at the endpoint (1.0, 1.0). This pattern demonstrates moderate inequality in the representation of sustainability themes.

The Lorenz curve's departure from the equality line indicates that themes such as environmental preservation and knowledge of climate change

were prioritized more often than those pertaining to social aspects and economic sustainability. Overall, the results show that secondary school sustainability education research continues to

focus more on environmental issues than on more general aspects of social and economic sustainability (Figure 2).

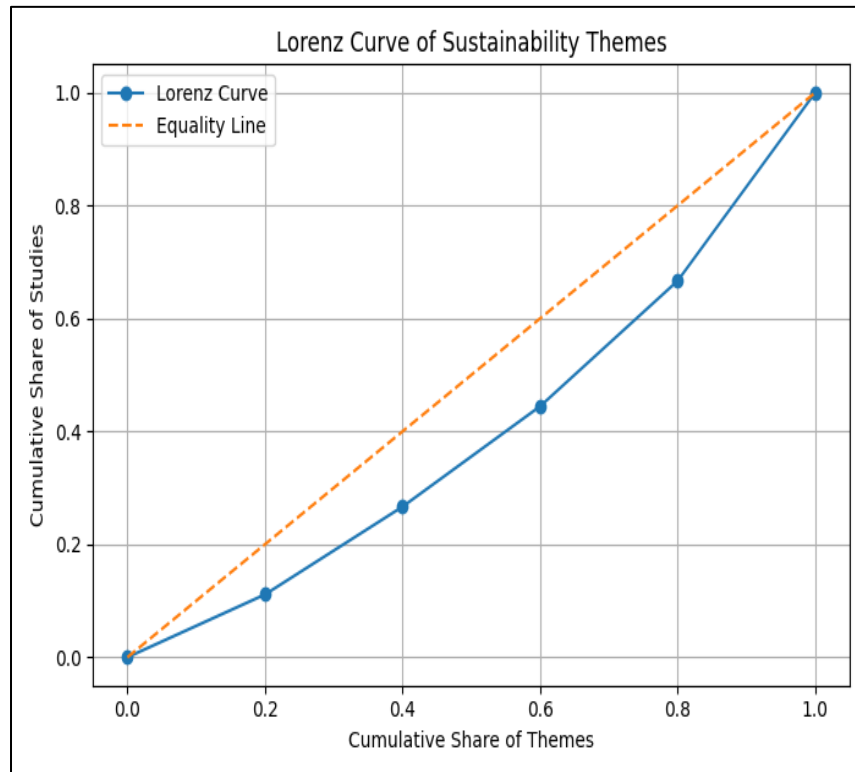


Figure 2: Lorenz Curve of Sustainability Themes

Participatory and Transformative Pedagogies

The distribution of transformative and participatory pedagogies in ESD (n = 45) is shown in Figure 3. Outdoor and field-based learning accounted for 26.7% of the studies, while community-based projects accounted for 28.9%. A total of 24.4% of learning was action-oriented, emphasizing the importance of student

participation and real-world sustainability initiatives. Twenty percent of the research used critical and reflective thinking techniques. Overall, the results show that to improve sustainability learning outcomes, ESD mainly stresses experiential, participatory, and learner-centered teaching methods.

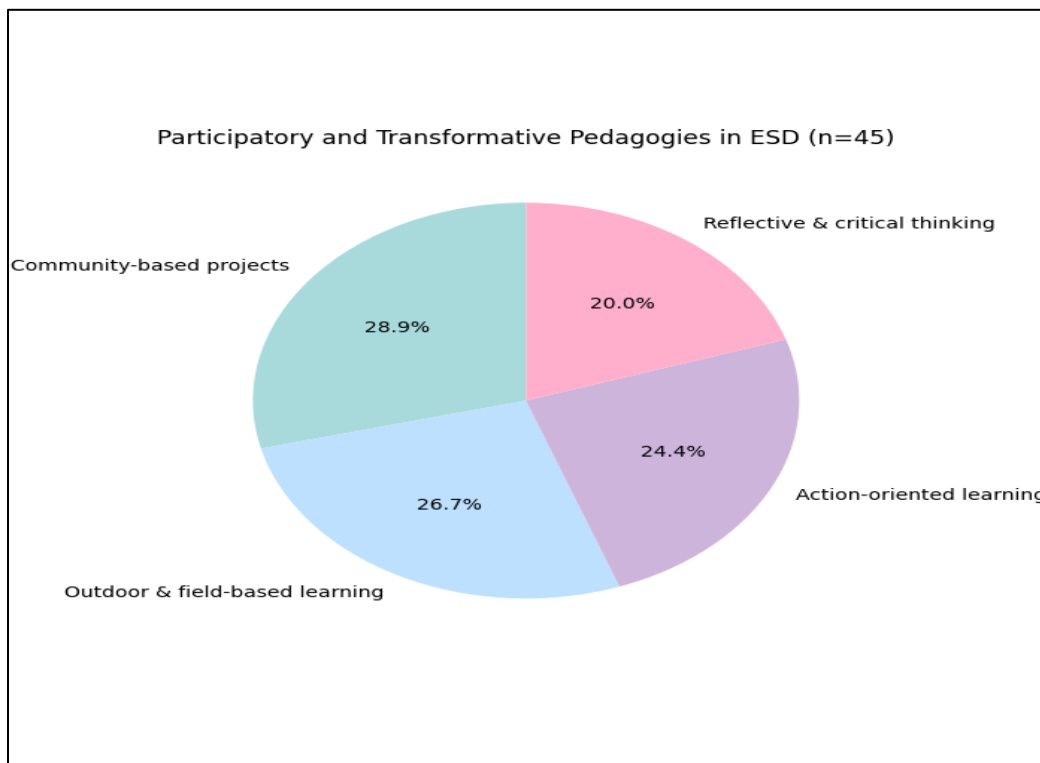


Figure 3: Pie chart for participatory and transformative pedagogies

Teacher preparedness and professional development Teachers' Knowledge and Understanding of ESD

Table 2 indicates that awareness of sustainability concepts was reported in 57.8% of the selected studies, showing that most teachers possessed a general understanding of environmental sustainability and related educational concepts. Teachers were aware of issues such as environmental conservation, climate change, and sustainable development principles, which supported the integration of sustainability topics into classroom teaching.

Understanding of sustainable development goals and international sustainability frameworks accounted for 42.2% of the reviewed studies. Although many educators demonstrated familiarity with sustainability concepts, fewer studies reported a detailed understanding of global sustainability policies such as SDG 4.7 and UNESCO sustainability initiatives. The findings suggest that teacher awareness of sustainability education is increasing, but additional professional training related to international sustainability frameworks is still needed.

Table 2: Teachers' Knowledge and Understanding of Education for Sustainable Development

Aspect of Knowledge & Understanding	Frequency (f)	Percentage (%)
Awareness of sustainability concepts	26	57.8%
Understanding of SDGs and frameworks	19	42.2%
Total	45	100%

Strategies to Improve Teacher Preparedness

Table 3 demonstrates that continuous professional development was the most frequently reported strategy for improving

teacher preparedness, accounting for 40.0% of the selected studies. Workshops, seminars, training sessions, and sustainability-focused teaching programs were commonly used to

strengthen teachers' knowledge and pedagogical skills related to education for sustainable development.

Institutional support and policy guidance represented 33.3% of the reviewed studies, highlighting the importance of curriculum reforms, administrative support, and educational policies in facilitating sustainability education.

Collaborative teaching and networking accounted for 26.7% of the studies and involved peer learning, interdisciplinary collaboration, and professional knowledge sharing among educators. Overall, the findings indicate that successful implementation of ESD depends on both teacher training opportunities and institutional support systems.

Table 3: Strategies Used to Improve Teacher Preparedness for ESD

Strategy	Frequency (f)	Percentage (%)
Continuous professional development	18	40.0%
Institutional support & policy guidance	15	33.3%
Collaborative teaching & networking	12	26.7%
Total	45	100%

Student Environmental Awareness

The key indications of student environmental awareness found in the chosen ESD research are shown in Figure 4. With a frequency of 14 studies, awareness of environmental issues was the most commonly reported indication. This shows that students' comprehension of pollution, biodiversity loss, conservation, and other environmental issues was much enhanced by sustainability education programs. After taking part in ESD activities, many students gained a greater understanding of climate change, global warming, and associated environmental dangers. Climate awareness was the second most reported indication, with a frequency of 11 studies. Ten studies reported positive attitudes toward environmental preservation, indicating that

students' positive perspectives and care for environmental conservation were also fostered by sustainability education.

Six studies demonstrated responsibility for sustainable behaviors, demonstrating the impact of ESD in encouraging ethical awareness and ecologically responsible behavior among students. Only one study reported the school environment and family/community effect, but two studies found that teaching approaches led to environmental awareness. These results show that students' environmental awareness was largely influenced by classroom instruction and sustainability-focused educational activities, while external social effects were given relatively little consideration in the examined research.

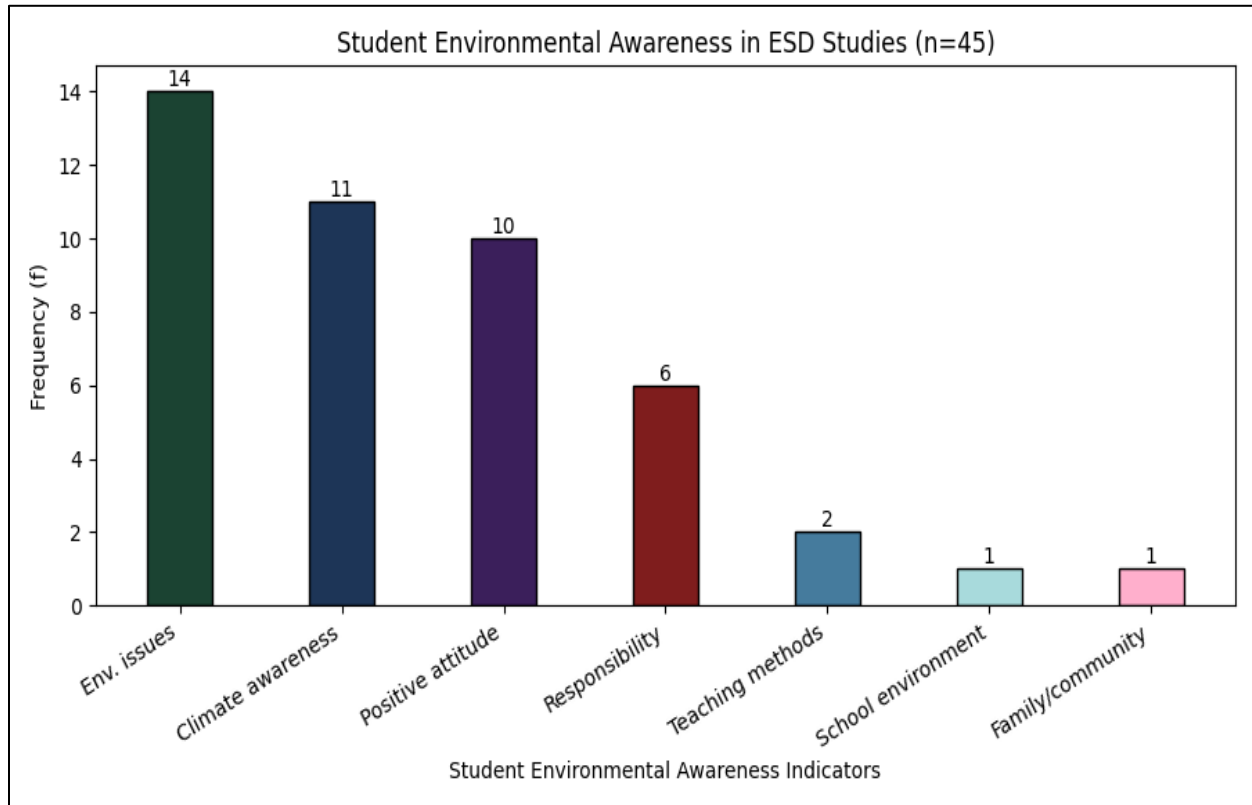


Figure 4: Student Environmental Awareness Outcomes Following ESD Implementation

Behavioral Change Outcomes

The results presented in the figures highlight the major themes and outcomes reported in the 45 reviewed studies on Education for Sustainable Development (ESD).

In Figure 5 “Behavioral Change Outcomes in ESD Studies,” the largest proportion of studies (26.7%) focused on recycling and waste reduction, indicating that ESD programs most frequently encourage practical environmental behaviors related to waste management. Energy and water conservation represented the second most common outcome (22.2%), showing that many studies emphasized responsible resource use and sustainable daily practices.

Environmental campaigns accounted for 17.8% of the findings, suggesting that ESD initiatives often motivate learners to participate in

awareness and advocacy activities. Similarly, willingness to act (15.6%) demonstrated that ESD contributes to developing positive attitudes and intentions toward sustainability. Civic engagement (8.9%) showed moderate attention, reflecting the role of ESD in promoting community participation and social responsibility. However, smaller percentages were reported for awareness–action gaps (4.4%), social or institutional barriers (2.2%), and short intervention duration (2.2%), indicating that although some studies identified challenges limiting behavioral transformation, these issues were less frequently explored. Overall, the findings suggest that ESD has a significant positive influence on environmentally responsible behaviors, particularly in areas directly linked to everyday sustainable practices (Figure 5).

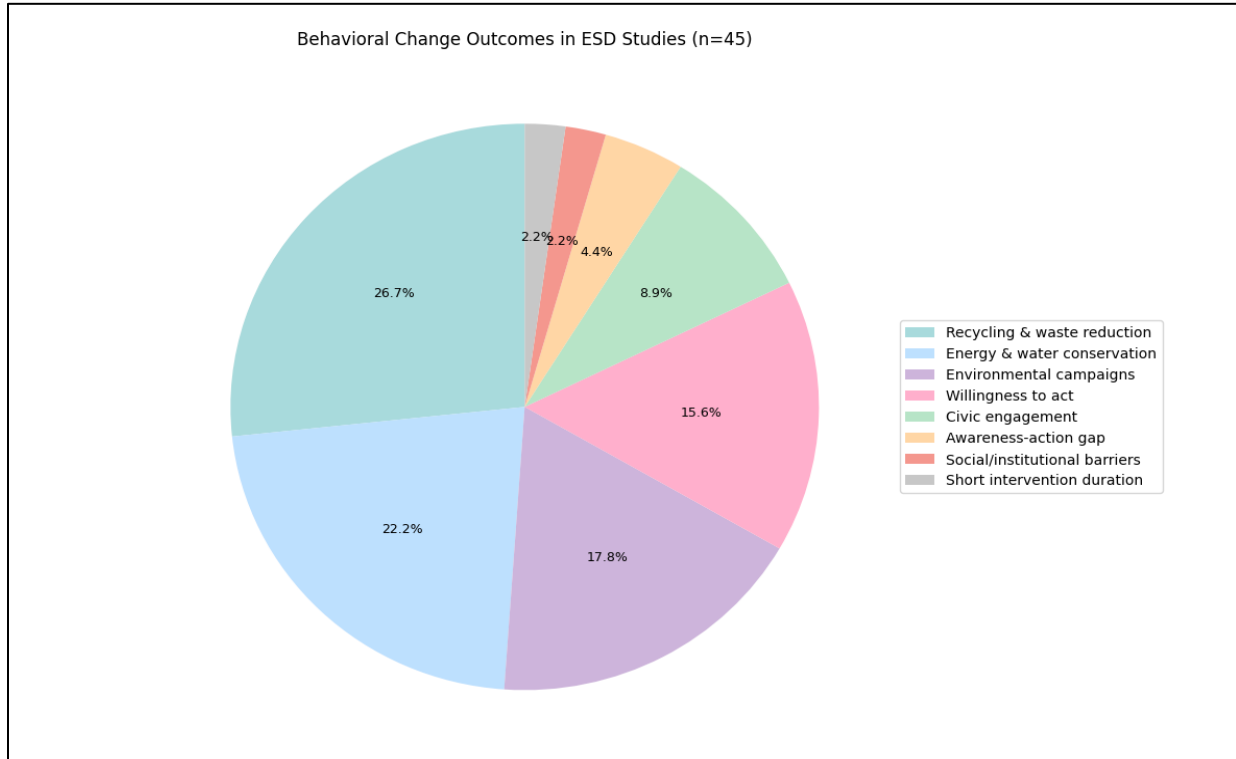


Figure 5: Distribution of behavioral change outcomes reported in Education for Sustainable Development (ESD) studies (n = 45).

Cross-National Policy Frameworks and Institutional Support

Cross-National Policy Frameworks in ESD, demonstrates the policy and institutional dimensions addressed across the reviewed studies. UNESCO ESD initiatives were the most frequently discussed framework (f = 10), highlighting the strong global influence of UNESCO in promoting sustainability education policies and practices. SDG 4.7 implementation ranked second (f = 8), emphasizing the importance of integrating sustainable development principles into education systems worldwide. Curriculum integration strategies (f = 7) and OECD sustainability frameworks (f = 6) were also widely examined, showing that many countries are attempting to embed sustainability concepts within formal educational curricula (Figure 6).

National sustainability policies (f = 5) and comparative country analyses (f = 3) reflected growing international efforts to evaluate and

strengthen ESD implementation. In contrast, funding and resource limitations (f = 2), lack of monitoring systems (f = 2), and regional implementation gaps (f = 1) revealed ongoing institutional challenges affecting the effectiveness of ESD programs. On the other hand, persistent institutional issues impacting the efficacy of ESD programs were identified by financing and resource constraints (f = 2), the absence of monitoring systems (f = 2), and regional implementation gaps (f = 1). There appears to be a research deficit in the documentation of advanced or emerging ESD models, since only one study highlighted successful ESD countries and no studies specifically focused on innovative initiatives. All of these results show that despite the substantial support for ESD adoption from international organizations and policy frameworks, implementation issues and the paucity of innovation-focused research continue to be significant difficulties (Figure 7).

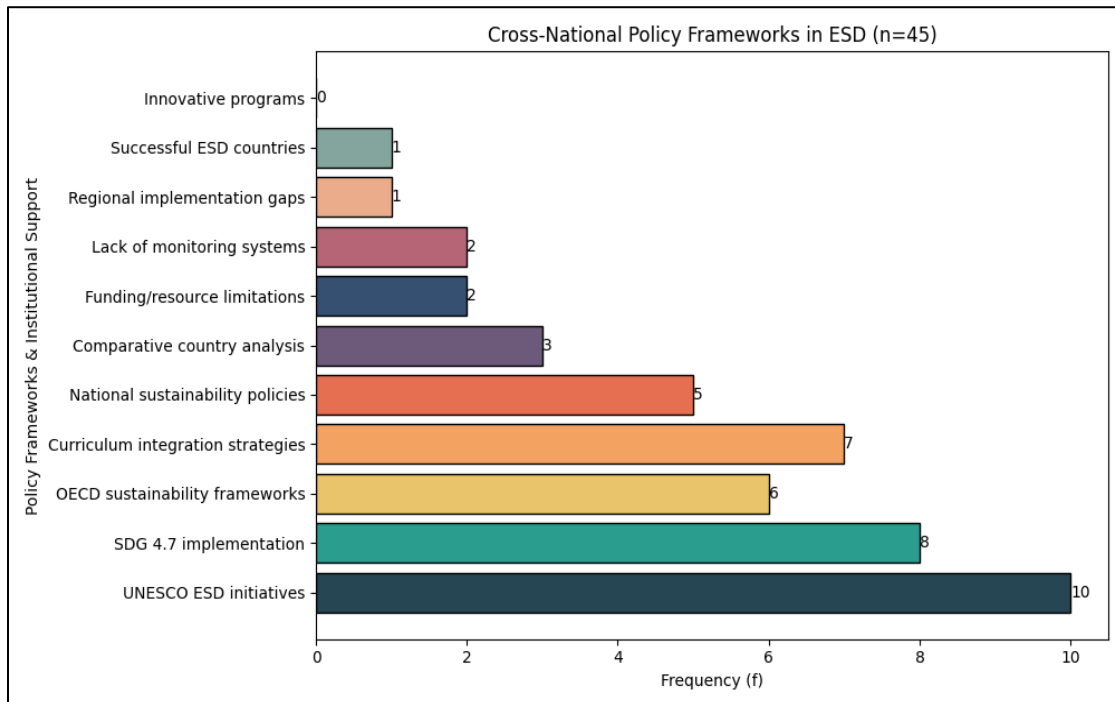


Figure 4.6: Cross-national policy frameworks and institutional dimensions addressed in Education for Sustainable Development (ESD) studies (n = 45).

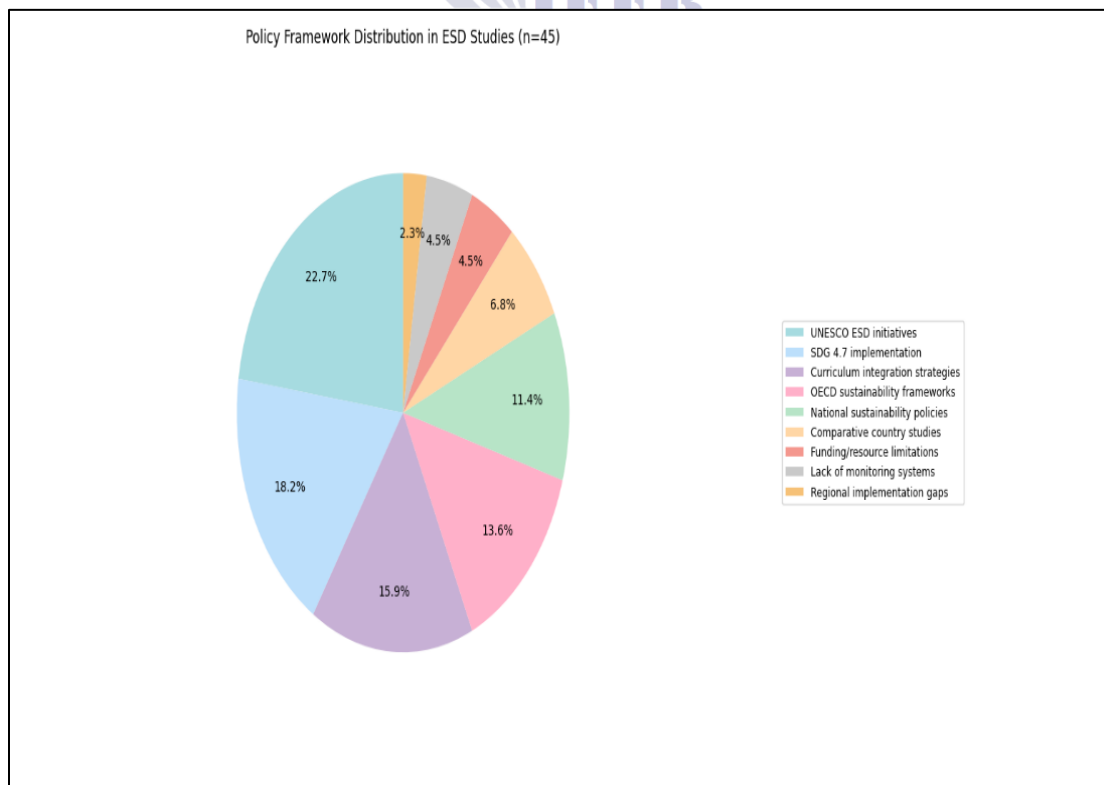


Figure 7: Pie chart for policy framework distribution in ESD studies

Major Themes and Emerging Trends

Table 4 shows that interdisciplinary learning emphasis was the most prominent emerging trend, accounting for 26.7% of the selected studies. This indicates that educational systems increasingly recognize the importance of integrating sustainability concepts across multiple academic disciplines to provide students with broader understanding of environmental, social, and economic sustainability issues.

Action-oriented sustainability education represented 22.2% of the reviewed studies and highlighted the growing emphasis on practical

learning, environmental participation, and student engagement in sustainability initiatives. Teacher professional development contributed 20.0%, while policy support for ESD integration accounted for 17.8%. Technology in sustainability education represented 13.3% of the studies and included the use of digital platforms and technology-assisted sustainability learning methods. Overall, the findings demonstrate an increasing focus on interdisciplinary, participatory, and technology-supported approaches in ESD research

Figure 4: Major themes and emerging trends in ESD research

Theme	Frequency (f)	Percentage (%)
Interdisciplinary learning emphasis	12	26.7
Action-oriented sustainability education	10	22.2
Teacher professional development	9	20.0
Policy support for ESD integration	8	17.8
Technology in sustainability education	6	13.3
Total	45	100

Discussion

Overview of studies

The findings show a rapid increase in research on Education for Sustainable Development (ESD), particularly after 2020, with more than half of the studies published between 2021 and 2025. This reflects the growing global emphasis on sustainable development goals (SDGs) and the integration of sustainability into education systems (Kumar & Arora, 2025; Abbas et al., 2025).

Geographically, Asia and Europe dominate the literature, indicating stronger policy support and institutional commitment in these regions, while Africa, North America, Oceania, and South America remain underrepresented. This suggests an imbalance in global research contributions and implementation of ESD practices.

Qualitative studies are the most prevalent in terms of methodology, emphasizing investigating experiences, attitudes, and classroom practices (Gutierrez-Bucheli et al., 2022; Gupta et al., 2024). Nonetheless, the existence of mixed methods and quantitative research indicates a progressive move toward more thorough analysis

techniques. The most researched setting is public secondary schools, which reflects their crucial role in putting sustainability education into practice (ElShafei, 2022; Oe et al., 2022). Overall, the results show that ESD is becoming more widely recognized, but they also point out gaps in methodological variety and geographical representation.

Curriculum integration approaches

The results of this review show that the most popular method for integrating Education for Sustainable Development (ESD) into secondary school curricula was multidisciplinary curriculum integration. To help students comprehend the connections between the environmental, social, and economic aspects of sustainability, sustainability themes were mostly incorporated into courses such as science, geography, and social studies. These results align with previous research indicating that multidisciplinary education fosters students' comprehensive comprehension of intricate sustainability issues (Walshe, 2008; Walshe, 2017; Balbin & Balbin, 2024).

Similarly, integrating sustainability themes across multiple subjects allows ESD to become part of regular classroom learning rather than remaining isolated within specific environmental courses (Hung and Pan, 2025; Kopnina and Meijers, 2014).

The review also found that project-based curriculum integration and participatory learning approaches were widely used in ESD implementation. Environmental campaigns, recycling projects, community-based activities, and sustainability-focused assignments encouraged active student participation and experiential learning. These findings support Transformative Learning Theory, which emphasizes experiential and reflective learning processes in promoting sustainability competencies (Ahmad and Sosa, 2025; Brannon, 2023).

According to earlier research, students' critical thinking, environmental responsibility, and problem-solving abilities are enhanced by inquiry-based learning, group projects, and action-oriented pedagogies (Panke and Harth, 2023; Bharti and Vij, 2026; Mothilal et al., 2025). Nonetheless, the review found that the curriculum placed uneven focus on sustainability themes. Themes relating to social justice, economic sustainability, and equity were less common than those relating to environmental conservation and climate change awareness. Globally, research on sustainability education is mostly focused on environmental aspects, with very little emphasis paid to larger socioeconomic aspects. Students' comprehension of sustainable development as a multifaceted notion comprising social, economic, and environmental interdependence may be limited by this imbalance (Meseguer-Sánchez et al., 2020; Strezov, Evans, and Evans, 2017; Simonneaux and Simonneaux, 2012).

Participatory and Transformative Pedagogies

The results showed that transformative and participatory pedagogies are important for the effective implementation of ESD. Numerous evaluated studies have highlighted inquiry-based learning, experiential learning, group problem

solving, and community-centered educational activities as successful approaches for teaching sustainability. Instead of passively absorbing theoretical knowledge, these instructional approaches inspire students to actively engage with real-world sustainability concerns. These results are consistent with the ideas of social constructivism, which emphasize social interaction and cooperative learning as crucial processes for knowledge formation. Fernando and Tajan (2024) highlighted that by encouraging students to critically analyse social and environmental challenges in their communities, participatory pedagogies raise awareness of sustainability. Students who receive action-oriented sustainability education are better equipped to acquire the pro-environmental attitudes and practical skills needed for sustainable living (Pan and Hsu, 2025; Chen and Liu, 2020; Weinberg et al., 2026).

Additionally, transformative pedagogies foster students' political engagement and ethical consciousness. Sustainability-focused events increased students' motivation to take part in environmental campaigns and community sustainability projects, according to a number of studies included in the review (Sahoo, 2025; Singh, 2025; Eichberg and Charles, 2024). In a similar vein, Frisk and Larson (2011) discovered that transformative sustainability education inspires students to reevaluate their own beliefs, actions, and way of life in light of global sustainability issues.

Teacher preparedness and professional development

Teacher preparedness emerged as one of the most important factors influencing the effectiveness of ESD integration into secondary school curricula. The findings showed that most teachers possessed general awareness of sustainability concepts such as environmental conservation and climate change (Manasia, Ianos and Chicioreanu, 2019). However, fewer educators demonstrated a detailed understanding of international sustainability frameworks, including SDG 4.7 and UNESCO sustainability initiatives. These findings correspond with previous studies

indicating that teachers often lack specialized sustainability training despite recognizing the importance of ESD (Bulut and Elci Oksuzoglu, 2025).

The most often suggested method for enhancing teacher readiness was found to be ongoing professional development. The examined studies frequently reported multidisciplinary collaboration, workshops, seminars, and sustainability-focused teacher education programs (Kalsoom and Qureshi, 2021; Lorente-Echeverría, Murillo-Pardo, and Canales-Lacruz, 2022). In a similar vein, Vidal and Kuckuck (2025) stressed that teachers must acquire both conceptual knowledge and pedagogical skills pertaining to ESD implementation to provide successful sustainability education.

Institutional support and policy guidance also played a critical role in facilitating sustainability education. Curriculum flexibility, administrative support, and access to teaching resources significantly influence teachers' ability to integrate sustainability themes into classroom instruction (Fullan, Hopkins and Spillane, 2008). Aleixo, Leal and Azeiteiro (2018) found that insufficient institutional support and limited training opportunities remain major barriers to sustainability education in many educational systems. These findings suggest that teacher preparedness cannot be improved solely through individual effort but requires broader educational policy support and institutional commitment.

Student Environmental Awareness

The review findings indicate that ESD positively contributes to students' environmental awareness and sustainability literacy. Most studies reported an improved understanding of environmental issues such as pollution, biodiversity loss, climate change, and conservation among students exposed to sustainability education programs. These findings are consistent with earlier research suggesting that ESD enhances environmental literacy and ecological awareness among learners (Li, 2025; Xiong et al., 2025; Liu & Li, 2025).

One of the most often cited results of sustainability education is climate awareness. Students gained a deeper comprehension of

environmental hazards, sustainable resource management techniques, and global warming. The reviewed studies also consistently found positive attitudes toward environmental protection, suggesting that sustainability education affects students' values and perceptions of environmental responsibility in addition to cognitive learning (Rickinson, 2001; Ardoin et al., 2020; Gupta et al., 2024).

However, the results also showed that family impact, community involvement, and social contexts received relatively less attention, whereas school-based learning activities were the main sources of environmental awareness (Azevedo et al., 2025; Ruiz-Mallén et al., 2022). In a similar vein, Wilson & Stevenson (2018) contended that to have a long-term sustainability impact, sustainability education should go beyond the classroom and incorporate social learning contexts and wider community involvement.

Behavioral Change Outcomes

The findings demonstrated that ESD contributes significantly to environmentally responsible behaviors among students. Recycling practices, waste reduction, energy conservation, and water conservation were among the most commonly reported behavioral outcomes in the reviewed studies. These findings support action competence theory, which emphasizes learners' ability to translate environmental knowledge into practical sustainable actions (Fielding et al., 2011; Wilson et al., 2025; Xia et al., 2023).

According to a number of studies, students' willingness to participate in sustainable practices in schools and communities rose when they were involved in environmental campaigns and sustainability projects. According to Uddin et al. (2026), students' environmental practices and civic involvement are positively impacted by experiential sustainability education. Additionally, environmental campaigns and awareness-raising events encouraged students to take responsibility for resource conservation and sustainable living.

Despite these favourable results, other research found awareness-action gaps, indicating that long-term behavioral change is not necessarily the

effect of raising environmental awareness. According to McPhail (2022), in addition to classroom learning experiences, behavioral transformation is dependent on broader institutional, cultural, and social impacts (Greenhill, 2025; MacPhail et al., 2022). The sustainability benefit of some ESD initiatives was also noted to be hampered by social barriers, scarce resources, and brief intervention durations.

Cross-National Policy Frameworks and Institutional Support

The results showed that national curricular revisions and sustainability education policies are heavily influenced by international sustainability frameworks, especially UNESCO initiatives and SDG 4.7. Among the analysed papers, UNESCO's Education for Sustainable Development programs were the most often addressed framework, indicating the organization's important role in advancing sustainability education worldwide (Oe et al., 2022).

Although implementation strategies differ depending on local educational priorities, socioeconomic circumstances, and institutional capacities, countries such as England, India, Norway, and Pakistan have increasingly incorporated sustainability themes into secondary school curricula (Kumar & Arora, 2025; Abbas et al., 2025). The incorporation of sustainability into educational systems has also been strengthened by national curriculum revisions and OECD sustainability frameworks. However, the analysis found a number of implementation issues that have an impact on the efficacy of ESD in different nations.

The obstacles that were frequently mentioned included financial constraints, a dearth of instructional materials, inadequate monitoring methods, and regional disparities. Without proper institutional support and financial allocation, policy inclusion on its own is insufficient. These results imply that long-term policy commitment, teacher support, and methodical implementation techniques are necessary for sustained curricular reform (McLure

& Aldridge, 2023; Senior et al., 2025; Agbabiaka & Albert, 2025).

Major Themes and Emerging Trends

The review's conclusions brought to light a number of new developments in ESD practice and research. The most notable trend was interdisciplinary learning, which reflects the growing understanding that sustainability concerns necessitate integrated educational approaches across different disciplines (Cai et al., 2024; Mokski et al., 2023). Additionally, much emphasis has been placed on action-oriented sustainability education, which suggests that experiential learning and student involvement in sustainability efforts are becoming increasingly important (Thanapornsanguth et al., 2025; Sass et al., 2024).

Key features in all of the analysed studies were policy support for ESD integration and teacher professional development. These results reinforce previous claims that supportive institutional frameworks and teacher competency are necessary for successful sustainability education (Fischer et al., 2026). With digital platforms and online learning resources progressively promoting sustainability awareness and cooperative learning activities, technology-assisted sustainability education has also become a significant trend (Hajj-Hassan et al., 2024).

Overall, the results indicate that education for sustainable development is progressively taking center stage in worldwide educational reform. Future studies, however, ought to delve deeper into long-term behavioral effects, creative teaching strategies, and the thoughtful incorporation of environmental, social, and economic sustainability aspects into secondary school curricula.

Conclusion

The findings of this systematic review demonstrate that Education for Sustainable Development has become an increasingly important component of secondary school curriculum reform worldwide. The growing number of studies published after 2020 reflects expanding global recognition of sustainability education in response to climate change,

environmental degradation, and the Sustainable Development Goals. The review confirmed that interdisciplinary curriculum integration, participatory pedagogies, and action-oriented learning approaches are highly effective in promoting sustainability competencies, environmental awareness, and pro environmental behaviors among students. Teacher preparedness, continuous professional development, and institutional support were identified as essential factors for successful ESD implementation.

Declarations

Ethics approval

The Institutional Ethics and Guideline Committee of the University of Lahore, Lahore Pakistan has allowed all the protocols used in this experiment. All the experimental methods of this study followed all the appropriate guidance and regulations.

Consent for publication

All subjects gave their “informed consent” for the publication of details within the text (“informed consent”) to be published in the above Journal and Article. Written “informed consent” was obtained from all authors for the publication of this manuscript.

Availability of data and materials

The data generated are provided within the manuscript and will be available from author at reasonable request

Competing Interest

All authors declare that there are no competing interests.

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