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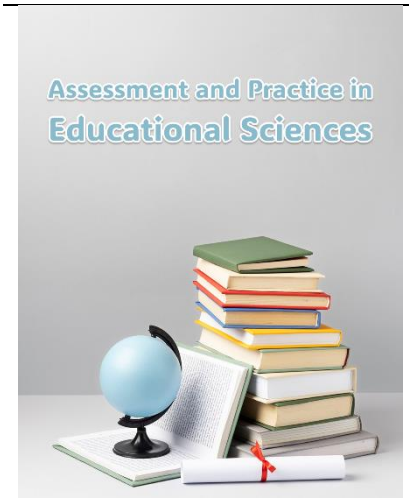

Qualitative Analysis of Curriculum Components Aligned with Education for Sustainable Development (ESD)

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1. Hossein. Baghaei: Department of Educational Studies and Curriculum Planning, Marand Branch, Islamic Azad University, Marand, Iran (Email: hosseinbmd@gmail.com)
2. Parisa. Valizad Ziyaei*: PhD Student, Department of Curriculum Planning, Marand Branch, Islamic Azad University, Marand, Iran
3. Fatemeh. Valipour: PhD Student, Department of Curriculum Planning, Marand Branch, Islamic Azad University, Marand, Iran
4. Raha. Gassabi Kaleybari: PhD Student, Department of Curriculum Planning, Marand Branch, Islamic Azad University, Marand, Iran
5. Parvin. Asgharzadeh: PhD Student, Department of Curriculum Planning, Marand Branch, Islamic Azad University, Marand, Iran

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ABSTRACT

The objective of this study was to qualitatively analyze the curriculum components aligned with Education for Sustainable Development (ESD) within the Iranian educational context. This study employed a qualitative research design with an interpretive approach to explore philosophical, pedagogical, structural, and institutional dimensions of ESD-based curriculum development. The participants consisted of 22 curriculum experts, teachers, and educational administrators from Tehran, selected through purposive sampling until theoretical saturation was achieved. Data were collected through semi-structured interviews lasting between 45 and 75 minutes and analyzed thematically using NVivo 14 software. Thematic coding involved open, axial, and selective stages, ensuring the identification of core categories and subthemes. Trustworthiness was established through member checking, peer debriefing, and audit trail procedures, and ethical approval was obtained from the Islamic Azad University, South Tehran Branch. The analysis revealed four major themes: (1) Curriculum philosophy and vision, emphasizing moral, ethical, and cultural contextualization of sustainability; (2) Pedagogical approaches and teaching strategies, highlighting experiential, participatory, and technology-enhanced learning; (3) Curriculum content and structure, focusing on interdisciplinary integration, policy alignment, and inclusion of environmental and socio-economic dimensions; and (4) Teacher capacity and institutional support, underlining the importance of professional development, institutional culture, and leadership commitment to ESD. Participants' narratives illustrated that effective ESD implementation requires coherence among curriculum philosophy, pedagogy, and governance mechanisms. The study concludes that achieving Education for Sustainable Development in Iran necessitates a transformative approach to curriculum design, integrating ethical foundations, innovative pedagogies, and systemic institutional support. Embedding sustainability principles within all educational levels can foster critical thinking, moral responsibility, and collective action toward sustainable futures.

Keywords: Education for Sustainable Development (ESD); curriculum design; sustainability pedagogy; qualitative research; Iran; thematic analysis; teacher professional development.

Introduction

Education for Sustainable Development (ESD) has emerged as a transformative paradigm in global education, aiming to equip learners with the knowledge, values, and competencies necessary to build a more just, resilient, and sustainable world.

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) defines ESD as an integrative educational process that empowers individuals to make informed decisions and take responsible actions for environmental integrity, economic viability, and social equity—both for present and future generations (1). The implementation of ESD within curriculum design is not merely an instructional adjustment but a philosophical reorientation that links education to the broader goals of sustainable development. In this regard, curriculum reform has become a key instrument for operationalizing sustainability principles at different educational levels, from early childhood to higher education (2, 3).

In recent years, scholars have emphasized that integrating sustainability into curricula requires rethinking the purpose, content, pedagogy, and structure of education systems (4, 5). It moves beyond the inclusion of environmental topics toward fostering transformative learning experiences that encourage critical thinking, systems understanding, and ethical action (6, 7). In higher education, alignment between Outcome-Based Education (OBE) frameworks and the Sustainable Development Goals (SDGs) has been highlighted as an effective strategy to institutionalize ESD principles (1). However, despite global momentum, there remain substantial challenges in ensuring coherence between sustainability policies and actual curricular practices, especially in developing educational contexts where cultural, institutional, and policy barriers often hinder meaningful integration (8, 9).

The evolution of sustainability-oriented curricula has revealed a tension between traditional subject-based instruction and interdisciplinary, competence-based approaches. Traditional curricula often prioritize cognitive learning outcomes while neglecting affective and behavioral dimensions that are crucial for sustainability literacy (10). As argued by (2), embedding ESD in curriculum design requires co-designing frameworks that engage teachers, learners, and stakeholders in participatory processes, leading to what has been called “transformative curriculum development.” This participatory character has been echoed in several educational systems that attempt to integrate ESD principles through localized models reflecting indigenous wisdom and community involvement (11). For instance, the “YANGKHINOK” model in Thailand demonstrates how local culture and sustainability can converge to create community-driven learning pathways (11).

Teacher education plays a vital role in realizing ESD objectives. Without adequately prepared educators, the translation of sustainability concepts into classroom realities remains limited (12, 13). Research across multiple contexts underscores the importance of cultivating teachers’ creativity, reflection, and connectedness to nature as foundational attributes for teaching sustainability (7, 14). This shift requires teacher training programs that emphasize critical pedagogy, problem-based learning, and interdisciplinary collaboration (15, 16). For example, in Croatia, studies show that teachers who feel personally connected to nature are more likely to implement sustainability principles in their teaching practice (7). Similarly, research in Sierra Leone highlights the sociological dimension of ESD, advocating for curricula that connect learners’ everyday social realities with sustainability challenges (14).

In the context of Islamic education, the ethical and epistemological dimensions of ESD have also been explored. (4) emphasized that ethical curriculum development rooted in Islamic epistemology can contribute significantly to achieving SDGs by integrating spiritual and moral awareness into sustainability teaching. This perspective underlines that sustainability is not only an environmental or economic concern but also a moral imperative that shapes human behavior and social justice. The ethical dimension of ESD thus necessitates curriculum frameworks that align with cultural and religious values while promoting universal human responsibility.

A growing body of evidence suggests that technological innovation and digital learning environments can enhance ESD integration. Smart technologies and data-driven educational platforms enable interactive learning experiences, virtual simulations, and global collaboration among learners (17). The digitalization of ESD fosters broader accessibility and engagement, as demonstrated in studies exploring the use of intelligent systems in higher education institutions to support

sustainable development objectives (17). Similarly, ecologized collaborative online international learning (COIL) models have been developed to connect students and educators worldwide to address complex sustainability issues (18). Such models illustrate how technological connectivity can bridge geographical and cultural divides, creating shared spaces for problem-solving and critical reflection on global sustainability challenges.

Despite these advancements, inconsistencies in curriculum design persist across different educational levels and disciplines. For instance, studies from Morocco and Hong Kong found that sustainability themes are often scattered across subjects without a coherent integrative framework (3, 8). In response, curriculum mapping and SDG course inventories have been introduced to identify gaps and promote interdisciplinary collaboration (8). Similarly, (19) documented the contribution of industry partnerships to embedding sustainability in professional curricula, showing that cross-sectoral collaboration can enrich educational content and connect learners to real-world contexts.

Local and national policy alignment also plays a decisive role in successful ESD implementation. (9) emphasized that curriculum reform for sustainability in small island developing states depends heavily on coherent policy frameworks that guide teacher education, content development, and evaluation mechanisms. However, research from developing regions, including Namibia and Botswana, reveals that limited institutional capacity and lack of evaluation tools constrain ESD integration (20, 21). In such contexts, the introduction of specific assessment instruments, such as the Staunch© criteria for sustainable education evaluation, provides a structured method for measuring progress toward sustainability-oriented learning outcomes (20).

The social dimension of ESD has also gained attention. Sustainability education increasingly addresses global citizenship, social justice, and community participation (14, 22). In Cyprus, for instance, teachers' practices related to sustainable nutrition illustrate how everyday behaviors can serve as entry points for broader ESD principles (22). Moreover, community-based models such as those observed in Indonesia emphasize empowering early childhood education (ECE) teachers to design operational curricula that embed ESD principles within local realities (23). Similarly, research from Vietnam points to the development of pedagogical students' competencies in curriculum innovation, highlighting the need for sustained institutional support to foster ESD competencies among future educators (12).

At the same time, there is growing acknowledgment of the affective and emotional aspects of sustainability education. Emotional engagement has been identified as a key driver for environmental action and social transformation (6). Climate change education, for example, must address learners' eco-anxiety, empathy, and sense of agency to inspire proactive behavior rather than passive concern (6). This perspective aligns with (24), who argues that geography education provides a unique platform for connecting affective learning with environmental and social awareness. Geography's integrative nature helps students understand spatial interdependence and fosters a sense of global citizenship.

In terms of curricular content, international comparisons reveal both progress and gaps in integrating sustainability topics. (25) conducted a cross-country analysis of health-related subjects in Asian and Pacific curricula and found that while sustainability themes are present, they are unevenly distributed and lack systemic integration. These findings resonate with (26), who highlighted that sustainable education worldwide still faces fragmentation in approach, especially when moving from policy intentions to classroom realities. This gap underscores the necessity of systemic frameworks that align curriculum content, pedagogy, teacher development, and institutional policies under a unified ESD vision.

From a managerial perspective, sustainability education also demands the redefinition of leadership roles and governance mechanisms within educational systems (16). School leaders, administrators, and policymakers must foster supportive environments for innovation, provide professional development opportunities, and establish evaluation systems that reward

sustainability initiatives (5). Moreover, as (20) notes, measuring the effectiveness of ESD requires robust assessment tools that capture learners' competencies, attitudes, and behaviors rather than relying solely on knowledge-based outcomes.

Across global contexts, the convergence of pedagogical innovation, cultural adaptation, and policy reform suggests that Education for Sustainable Development is moving from theoretical discourse to practical transformation. However, progress remains uneven, especially in contexts where educational systems are still oriented toward traditional knowledge transmission rather than transformative learning (19, 27). As (27) observed, awareness of the SDGs among students remains relatively low, indicating that curricular initiatives have yet to fully translate into meaningful learning experiences.

Given this background, it becomes essential to conduct localized research to identify the specific curriculum components that effectively align with ESD principles within different cultural and institutional contexts. In Iran, where national education reform increasingly emphasizes moral and cultural dimensions, understanding how sustainability can be embedded in curriculum philosophy, content, and pedagogy is both timely and necessary. Therefore, the aim of the present study is to qualitatively analyze the curriculum components aligned with Education for Sustainable Development (ESD) in the context of Iran's educational system.

Methods and Materials

This study employed a qualitative research design using a content-based interpretive approach to explore and analyze curriculum components aligned with Education for Sustainable Development (ESD). The research aimed to uncover the underlying concepts, principles, and structural elements that promote sustainability-oriented education in Iran's educational context. A purposive sampling method was used to select 22 participants who had rich experience and expertise in curriculum studies, sustainable education, and educational policy-making. The participants included university faculty members, curriculum planners, education supervisors, and teachers with at least five years of experience in curriculum design or implementation of sustainability-based educational programs. All participants were based in Tehran. Sampling continued until theoretical saturation was achieved—that is, when no new categories or themes emerged from the data and additional interviews yielded redundant information.

Data were collected through semi-structured, in-depth interviews conducted between February and June 2025. Each interview lasted between 45 and 75 minutes, depending on the participant's availability and the depth of discussion. The interview protocol included open-ended questions designed to elicit participants' perspectives on ESD-aligned curriculum components, such as pedagogical approaches, values, competencies, and policy integration. Sample questions included: *"What elements do you consider essential for embedding sustainability principles into school curricula?"* and *"How can current educational practices be modified to support sustainable development goals?"*

All interviews were conducted in Persian, audio-recorded with participants' consent, and later transcribed verbatim for analysis. To ensure the trustworthiness of data collection, procedures such as member checking and peer debriefing were employed. Participants were allowed to review the transcripts and preliminary interpretations to confirm accuracy and authenticity.

Data analysis followed a thematic analysis procedure consistent with the qualitative paradigm. The transcribed interviews were systematically coded and analyzed using *NVivo 14* software to facilitate data organization, coding, and theme development. The analysis began with open coding to identify meaningful units and recurring patterns within the data. Subsequently, axial coding was used to establish relationships among codes, and selective coding was conducted to develop overarching categories that represent the core components of ESD-aligned curricula.

To enhance the credibility and reliability of the findings, the researchers employed triangulation through cross-validation of interpretations among team members and maintained an audit trail of analytic decisions throughout the process. The final thematic framework reflected the convergence of participants' experiences and conceptual understandings regarding how curricula can effectively integrate sustainability principles.

Findings and Results

A total of 22 participants took part in this qualitative study, all of whom were residents of Tehran, Iran and had direct professional involvement in curriculum design, educational planning, or sustainability-oriented instruction. The participants included 9 university faculty members (40.9%), 6 curriculum developers and policymakers (27.3%), 5 secondary school teachers (22.7%), and 2 education administrators (9.1%). The age range of participants was 31 to 59 years, with a mean age of 44.7 years. In terms of gender distribution, 12 participants were female (54.5%) and 10 were male (45.5%). The participants' professional experience varied from 7 to 28 years (average of 16.3 years), indicating a sample with considerable expertise in the field of education. Regarding academic qualifications, 15 participants (68.2%) held a Ph.D. in education or curriculum studies, while 7 participants (31.8%) possessed a master's degree in related fields such as educational management, environmental education, or social sciences. This demographic composition ensured a balanced representation of expert views from both academic and professional sectors within Tehran's educational system.

Table 1. Themes, Subthemes, and Concepts of ESD-Aligned Curriculum Components

Main Themes (Categories)	Subthemes (Subcategories)	Concepts (Open Codes)
1. Curriculum Philosophy and Vision	1.1. Sustainable Human Development Orientation	Emphasis on balance between human and environmental needs; long-term developmental vision; holistic learning; moral responsibility; intergenerational equity
	1.2. Ethical and Value-Based Foundations	Inclusion of ethical reasoning; empathy and respect for life; environmental ethics; justice and equality; social responsibility
	1.3. Cultural Adaptation to Local Context	Integration of Iranian cultural identity; contextualization of sustainability; local ecological issues; indigenous knowledge; respect for traditional wisdom
	1.4. Future-Oriented Curriculum Goals	Anticipatory learning; foresight and scenario planning; critical reflection on future risks; sustainability foresight; adaptive mindset
	1.5. Interdisciplinary and Systemic Thinking	Cross-disciplinary integration; connection between science, society, and environment; systems perspective; multi-level linkages; holistic knowledge structures
2. Pedagogical Approaches and Teaching Strategies	2.1. Experiential and Inquiry-Based Learning	Problem-solving projects; field observations; reflective discussions; student-led investigations; hands-on activities
	2.2. Collaborative and Participatory Methods	Group learning; peer teaching; community-based projects; democratic classrooms; participatory reflection
	2.3. Critical and Transformative Pedagogy	Encouraging questioning; challenging unsustainable norms; dialogue for change; empowerment of learners; socio-political awareness
	2.4. Digital and Innovative Learning Tools	Integration of ICT; digital storytelling; gamification; online sustainability modules; interactive simulations; virtual labs
	2.5. Values and Action-Oriented Learning	Linking values to behaviors; sustainability pledges; service learning; civic engagement; behavior modeling
3. Curriculum Content and Structure	3.1. Integration of Environmental Literacy	Climate change awareness; biodiversity topics; sustainable resource use; waste management; energy efficiency
	3.2. Socioeconomic and Cultural Dimensions of Sustainability	Poverty reduction; social justice education; equitable development; cultural diversity; global citizenship
	3.3. Life Skills and Competency-Based Content	Critical thinking; creativity; self-regulation; problem-solving; decision-making
	3.4. Policy and Curriculum Alignment	Inclusion in national curriculum standards; cross-ministerial coordination; ESD in educational goals; curriculum reform mechanisms
	3.5. Integration of Global Goals (SDGs)	Embedding SDG targets; global-local linkages; human rights education; sustainable consumption patterns
	3.6. Curriculum Flexibility and Adaptability	Modular curriculum design; local curriculum innovation; flexible learning pathways; teacher autonomy

4. Teacher Capacity and Institutional Support	4.1. Teacher Professional Development for ESD	Sustainability pedagogy training; lifelong learning; mentoring systems; capacity building workshops; experiential teacher learning
	4.2. Leadership and Administrative Support	Supportive school leadership; ESD-oriented management; institutional vision alignment; participatory decision-making
	4.3. Evaluation and Quality Assurance Mechanisms	Sustainability indicators; formative assessment tools; student portfolio evaluation; performance monitoring; reflective self-assessment
	4.4. Community and Stakeholder Engagement	Collaboration with NGOs; parental involvement; partnerships with local authorities; public awareness campaigns; social participation
	4.5. Resource Availability and Infrastructure	Access to teaching materials; sustainability labs; digital platforms; eco-school environments; budgetary support; green campus initiatives
	4.6. Policy and Governance Frameworks	National policy coherence; top-down and bottom-up integration; incentive systems for ESD; regulatory frameworks; accountability mechanisms
	4.7. Institutional Culture of Sustainability	Shared values among staff; sustainability mission statements; role modeling by administrators; continuous improvement culture

1. Curriculum Philosophy and Vision

The first main theme, *Curriculum Philosophy and Vision*, reflected participants' emphasis on the need for a fundamental transformation in the philosophical and ethical foundations of the national curriculum toward sustainable human development. Participants frequently highlighted the importance of a sustainable human development orientation, noting that education should balance human progress with environmental preservation and moral responsibility. As one university professor stated, *"Our curriculum must go beyond producing skilled workers—it must form responsible citizens who understand the planet's limits."* Ethical and value-based foundations were also viewed as central, with participants emphasizing values such as empathy, justice, and respect for all living beings. One curriculum expert noted, *"If students do not internalize compassion and fairness, sustainability education remains theoretical."* Cultural adaptation emerged as another subtheme, reflecting the integration of local identity and indigenous wisdom in sustainability teaching. Teachers from Tehran schools stressed the necessity of *"connecting global sustainability goals with local cultural practices and religious ethics."*

Participants also underscored the future-oriented nature of ESD curricula, emphasizing anticipatory and critical thinking to prepare learners for global and environmental challenges. As one participant described, *"Our students need to imagine futures, not just memorize facts."* Finally, the theme of interdisciplinary and systemic thinking appeared strongly, suggesting that curriculum content must integrate scientific, social, and ethical dimensions. According to another expert, *"We cannot separate environment from economy or ethics—ESD is about connecting the dots."* Together, these perspectives show that the philosophical and visionary basis of the ESD curriculum is grounded in holistic, ethical, and context-sensitive learning principles.

2. Pedagogical Approaches and Teaching Strategies

The second theme, *Pedagogical Approaches and Teaching Strategies*, centered on the instructional processes that can effectively operationalize sustainability principles in the classroom. Participants highlighted the role of experiential and inquiry-based learning, encouraging students to explore real-world issues through projects, fieldwork, and problem-solving. One participant stated, *"When students plant trees or monitor local air quality, sustainability becomes real and personal."* Another emphasized that active learning *"helps students question their consumption habits and understand environmental consequences."*

The theme also revealed the importance of collaborative and participatory teaching, promoting teamwork, dialogue, and democratic classroom practices. Teachers described success in "community-based projects where students cooperated with local organizations." Additionally, critical and transformative pedagogy was cited as vital to challenge unsustainable norms and empower students to act. As one respondent explained, *"Education must not just transfer knowledge but transform attitudes toward society and the environment."*

Participants further discussed digital and innovative learning tools, noting how virtual labs, simulations, and gamified sustainability modules can enhance engagement. *"Technology can connect students to global environmental issues instantly,"* remarked one teacher. Lastly, values and action-oriented learning were emphasized as the bridge between knowledge and behavior. A policymaker summarized this well: *"Sustainability is not just about knowing; it's about doing—students must experience responsibility."* Overall, participants viewed pedagogy as the engine that converts sustainability ideals into tangible educational practice.

3. Curriculum Content and Structure

The third major theme, *Curriculum Content and Structure*, encompassed the integration of sustainability across subject areas, life skills, and national education frameworks. The most prominent subtheme was the integration of environmental literacy, with participants calling for inclusion of topics such as climate change, biodiversity, and renewable energy within science and social studies curricula. A teacher explained, *"Students learn about recycling in isolation, but they need to understand the system behind waste and consumption."*

The socioeconomic and cultural dimensions of sustainability also received attention, as participants argued that ESD should address inequality, poverty, and cultural diversity. As one curriculum designer stated, *"We cannot talk about sustainability without addressing justice and inclusion."* Another emphasized the need to "teach students to see sustainability as a moral and civic duty."

The data revealed growing recognition of competency-based content, focusing on critical thinking, creativity, and decision-making as essential skills for sustainability. Moreover, participants underlined the need for policy and curriculum alignment, ensuring that sustainability principles are embedded in national standards and school objectives. *"If the curriculum policy does not explicitly mention sustainability, schools won't prioritize it,"* said one educational planner. The integration of global goals (SDGs) also emerged as a key point, promoting students' awareness of international sustainability frameworks while adapting them to local realities. Finally, curriculum flexibility and adaptability were viewed as crucial to allow schools and teachers to tailor lessons to regional and cultural contexts. One participant remarked, *"Flexibility in content empowers teachers to relate sustainability to students' daily lives."* Collectively, these findings suggest that the structure and content of an ESD-aligned curriculum must be both globally informed and locally grounded.

4. Teacher Capacity and Institutional Support

The final theme, *Teacher Capacity and Institutional Support*, focused on the enabling conditions necessary to implement ESD effectively within educational institutions. The participants agreed that teacher professional development is the cornerstone of successful sustainability education. As one academic expert stated, *"Teachers can only teach sustainability if they have experienced it—training must go beyond theory."* Workshops, mentoring programs, and experiential training were identified as essential strategies for empowering educators.

Furthermore, participants highlighted the significance of leadership and administrative support, emphasizing that school leaders must champion sustainability as a shared institutional vision. *"If principals don't model ESD values, teachers feel isolated,"* said a teacher. Another subtheme involved evaluation and quality assurance mechanisms, suggesting the use of formative and reflective assessments to measure sustainability competencies rather than rote learning.

Participants also underscored the importance of community and stakeholder engagement, calling for collaboration with NGOs, parents, and local authorities to reinforce ESD values. One participant shared, *"When parents and schools work together on environmental projects, the learning extends beyond the classroom."* The themes of resource availability and infrastructure and policy and governance frameworks were also recurrent. Respondents pointed to the need for eco-friendly facilities, digital resources, and coherent national policies to institutionalize ESD practices. Finally, the notion of institutional culture of

sustainability emerged as a unifying factor—schools must embody the principles they teach. As one curriculum supervisor expressed, *"Sustainability cannot be taught effectively unless it is lived daily in the school's culture."*

Overall, this theme revealed that sustainable education requires not only competent teachers but also supportive systems, resources, and leadership that nurture a long-term institutional commitment to ESD.

Discussion and Conclusion

The findings of this qualitative study revealed four overarching themes—curriculum philosophy and vision, pedagogical approaches and teaching strategies, curriculum content and structure, and teacher capacity and institutional support—each highlighting how curriculum components can be aligned with Education for Sustainable Development (ESD) in the Iranian educational context. These themes collectively suggest that implementing ESD requires not only content integration but also a deep philosophical and structural reorientation of the education system toward sustainability. The results resonate with a growing body of international evidence that emphasizes ESD as a holistic transformation involving values, competencies, pedagogy, and institutional culture (1-3).

The study found that participants strongly emphasized the philosophical and ethical foundations of an ESD-aligned curriculum. They highlighted sustainability as a guiding worldview rather than a supplementary educational topic. This mirrors findings from (4), who argued that curriculum development grounded in ethical and spiritual epistemology strengthens learners' moral awareness and social responsibility. Similarly, (9) found that small island states' curricular frameworks benefit from aligning sustainability with cultural identity and moral reasoning. Participants in the present study described sustainability education as "a form of moral education," consistent with (2), who proposed the CoDesignS framework for embedding ethical reflection into sustainability-oriented curriculum design.

Furthermore, the emphasis on cultural contextualization—linking global sustainability principles with local Iranian values—parallels the experience in Thailand's "YANGKHINOK" model, which integrates local wisdom with environmental learning (11). This supports the view that ESD is most effective when grounded in indigenous and cultural contexts rather than applied through imported educational models (22). Participants' repeated references to "contextual ethics" and "cultural adaptation" indicate that ESD in Iran requires sensitivity to local traditions, religious worldviews, and community practices. As (14) also found in Sierra Leone, sustainability education succeeds when it resonates with learners' lived social realities.

The future-oriented and systemic vision articulated by participants aligns with global perspectives advocating anticipatory learning and systems thinking (10, 24). In this sense, the philosophical basis of the ESD curriculum in Iran converges with international discourse that positions education as a driver for long-term planetary stewardship and collective well-being. As (1) emphasized, such transformation requires aligning learning outcomes with the Sustainable Development Goals (SDGs) to ensure measurable and outcome-based progress.

The results also indicated that transformative pedagogy is central to realizing ESD objectives. Participants underscored experiential learning, critical thinking, and participatory engagement as fundamental strategies for developing sustainability competencies. These findings align with (15), who demonstrated that problem-based learning (PBL) in design education promotes collaboration, innovation, and social awareness—key components of sustainable education. Likewise, (18) showed that ecologized collaborative online international learning (COIL) enables learners to tackle complex sustainability issues through cooperative, transnational problem-solving.

Participants in this study described how "students must experience sustainability, not just study it," echoing (12), who argued that curriculum development competency among pedagogical students is enhanced through active, inquiry-based learning environments. The prominence of collaborative methods, including peer learning and community engagement, is also supported

by (13), who found that teacher creativity in Technical and Vocational Education and Training (TVET) contexts directly contributes to fostering sustainability-oriented mindsets.

Critical pedagogy also emerged as an important element, emphasizing empowerment and socio-political awareness. This observation is consistent with (7), who reported that teachers' connectedness to nature enhances their commitment to transformative teaching in sustainability education. Similarly, the integration of emotional learning and environmental empathy, as noted by (6), underscores the role of affective engagement in motivating students to act on sustainability concerns. The findings thus support a pedagogical model that blends experiential, cognitive, and emotional dimensions—fostering both intellectual and moral readiness for sustainable citizenship.

Digital innovation was another key subtheme. Participants recognized technology's role in facilitating interactive, personalized, and globalized ESD experiences. This aligns with (17), who found that smart technologies enhance engagement with sustainability concepts in higher education institutions. Similarly, (18) emphasized that digital collaboration not only extends learning opportunities but also cultivates intercultural understanding, a critical aspect of global sustainability. The study's finding that "technology brings sustainability closer to students' daily experiences" suggests that ESD pedagogy in Iran should increasingly leverage digital platforms, simulations, and virtual fieldwork to promote systems thinking and real-world problem-solving.

The third major theme concerned the content and structural alignment of curricula with sustainability goals. Participants stressed the integration of environmental literacy, socioeconomic equity, and global citizenship within all educational levels. This reflects the findings of (3), who analyzed the integration of ESD into Morocco's life and earth sciences curriculum and found that sustainability principles remain scattered unless organized through coherent curricular structures. Similarly, (8) proposed SDG course inventories as a method to evaluate the extent of sustainability integration in higher education, highlighting the need for systemic approaches rather than fragmented inclusion.

The present study's finding that curriculum flexibility is essential for effective ESD implementation parallels the experiences of (19), who reported that dynamic curriculum design in event management education facilitated real-world sustainability applications. In the Iranian context, this flexibility would allow teachers to localize sustainability topics according to regional and cultural conditions, thereby promoting relevance and learner engagement. The integration of interdisciplinary content aligns with global trends toward holistic curriculum design, as seen in Croatia and Cyprus, where educators combine environmental, technological, and social topics to foster integrated sustainability understanding (10, 22).

Moreover, participants' emphasis on policy alignment underscores the need for structural reforms that embed sustainability in national education frameworks. This is consistent with (9), who identified curriculum policy coherence as a determining factor for ESD implementation. (5) also highlighted that involving experts in linking sustainability and disciplinary content ensures more effective curriculum integration. The findings therefore reinforce the notion that sustainable education cannot be achieved through isolated teaching efforts but requires systemic coherence among policy, content, and pedagogy.

The final theme—teacher capacity and institutional support—emerged as both a challenge and an opportunity. Participants emphasized that the success of ESD initiatives depends largely on teachers' professional competencies, institutional vision, and leadership commitment. This aligns with (12), who found that teacher education programs must strengthen students' curriculum development skills to sustain long-term ESD integration. Similarly, (16) stressed the need for managerial training in ESD to ensure that educational leaders can guide schools toward sustainability-oriented reforms.

Teacher training as a continuous, reflective process resonates with the recommendations of (7) and (13), who emphasized that sustained professional development cultivates creativity, empathy, and agency among educators. Participants in this study described professional learning communities and peer mentorship as essential supports for teachers seeking to embed

sustainability concepts in their practice. These findings also parallel (14), who demonstrated that teachers in socially diverse environments require institutional support to connect classroom learning with local sustainability issues.

Institutional culture was another recurrent subtheme. The participants' observations that "sustainability must be lived in the school" reflect the broader principle that schools themselves should serve as sustainable learning environments. This notion echoes (24), who highlighted that geography and sustainability education at the school level should extend beyond textbooks into the physical and cultural life of institutions. Furthermore, (26) noted that a global shift toward whole-school sustainability approaches fosters not only student learning but also institutional transformation. The Iranian participants' focus on "leadership modeling" and "collective responsibility" suggests an emerging awareness that institutional ethos and leadership behavior are vital for embedding sustainability deeply within the education system.

Finally, the need for evaluation mechanisms and measurable indicators for ESD implementation was evident. This aligns with (20), who introduced the Staunch© criteria for assessing sustainability education outcomes. Similarly, (21) found that assessment practices play a critical role in ensuring inclusivity and relevance in sustainability-oriented curricula. The current study reinforces these findings by showing that evaluation tools grounded in reflective and participatory assessment can help educators and administrators track progress toward sustainability objectives.

Although this study provides rich insights into curriculum components aligned with Education for Sustainable Development, it has several limitations. First, the qualitative design and purposive sampling limit the generalizability of findings beyond the Tehran educational context. While the data achieved theoretical saturation, the sample size of 22 participants may not capture the full diversity of perspectives from rural regions or other provinces of Iran. Second, since data were derived exclusively from semi-structured interviews, the findings rely on participants' self-reported experiences, which may be influenced by social desirability or institutional expectations. Additionally, while NVivo 14 facilitated systematic coding, thematic interpretation remains partly subjective and shaped by the researchers' analytical perspective. Future studies using mixed methods, classroom observations, and document analyses could yield a more comprehensive understanding of ESD integration across educational settings. Lastly, the study's focus on curricular components did not explore the role of broader political, economic, and societal factors that shape sustainability education policies.

Future research should investigate the longitudinal effects of implementing ESD-aligned curricula on students' competencies, values, and behaviors across different educational levels. Comparative studies between urban and rural schools in Iran could reveal contextual variations in sustainability practices and teacher readiness. Researchers might also explore how digital technologies and virtual learning environments can enhance experiential sustainability learning, especially in resource-constrained contexts. Additionally, cross-cultural studies comparing Iran with other Middle Eastern and Asian countries could help identify region-specific challenges and culturally grounded solutions. Finally, future inquiries should integrate policy analysis to examine how national education standards and institutional governance frameworks either support or hinder ESD implementation.

To translate these findings into actionable educational practice, curriculum developers should embed sustainability principles across all levels of education, ensuring coherence between philosophical foundations, pedagogy, and assessment. Teacher training institutions should integrate sustainability pedagogy into pre-service and in-service programs, emphasizing experiential learning and critical reflection. Educational leaders and policymakers should cultivate institutional cultures that model sustainability through eco-friendly practices, participatory decision-making, and community partnerships. Finally, national education authorities should establish evaluation frameworks that measure not only academic achievement but also students' sustainability competencies, ethical reasoning, and civic engagement. By aligning curriculum, teaching, and institutional vision, Iranian education can advance toward a more sustainable and socially responsible future.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

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

Transparency of Data

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

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