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Sustainability Education in Undergraduate Curricula: A Comparative Literature Review Across Disciplines

Thanh Tung Pham[1,2*]
[1]School of Civil Engineering and Management, International University, Ho Chi Minh City, Viet Nam
[2]Vietnam National University, Ho Chi Minh City, Viet Nam

***Abstract*: This literature review examines how sustainability education is integrated across six undergraduate disciplines: engineering, business and management, humanities, law, health sciences, and teacher education. Focusing on main themes, pedagogical strategies, and implementation challenges, the review identifies both common trends and discipline-specific approaches. Findings reveal shared commitments to ethical and environmental responsibility, but varied methods shaped by each field's traditions and goals. The review highlights the need for interdisciplinary collaboration, improved faculty development, and long-term assessment of educational impact to strengthen sustainability education in higher education.**

***Keywords*: sustainability education, disciplinary perspectives, pedagogy, higher education, curriculum integration.**

1. Introduction

Sustainability education in higher education is increasingly recognized as critical for addressing complex global challenges such as climate change, environmental degradation, social inequity, and economic sustainability (Brundiers et al., 2021). Higher education institutions (HEIs) are pivotal in equipping undergraduate students with the competencies necessary to navigate these complex issues, transforming them into informed, responsible, and proactive citizens (Wiek et al., 2011). However, approaches to teaching sustainability vary significantly across academic disciplines due to differences in disciplinary traditions, curricular structures, educational outcomes, and professional expectations (Mulder, Segalàs, & Ferrer-Balas, 2015).

Previous research underscores that disciplines such as engineering, business and management, humanities, law, health sciences, and teacher education each embed sustainability differently, shaped by their unique epistemological frameworks and educational contexts (Leal Filho, Shiel, & Paço, 2019; Mogren, Gericke, & Scherp, 2020). For example, engineering programs commonly emphasize technical solutions and environmental systems (Sánchez-Carracedo, Martí, & Sureda, 2018), whereas business and management education highlights corporate social responsibility (CSR), ethics, and sustainable strategy (Haski-Leventhal, Pournader, & McKinnon, 2021). Conversely, humanities education often approaches sustainability through ethical reflection and cultural narratives (Oppermann & Iovino, 2017), and legal education integrates sustainability primarily through regulatory frameworks and environmental law (Kotzé & French, 2018). Meanwhile, health sciences education increasingly emphasizes planetary health and sustainable healthcare systems (Gottlieb, Tait, & Sampson, 2020), and teacher education utilizes Education for Sustainable Development (ESD) frameworks to instill sustainability across diverse subject areas (Evans, Whitehouse, & Gooch, 2017).

Despite these differences, there are notable similarities in the challenges faced by these disciplines, including limited faculty expertise, curricular overcrowding, institutional barriers, and difficulties in integrating interdisciplinary perspectives effectively (Rose, Breunig, & Mair, 2020; Mortimer, Isherwood, Wilkinson, & Vaux, 2021). There is a clear need to systematically examine these disciplinary similarities and differences to better understand how sustainability can be effectively embedded across undergraduate programs.

This literature review aims to explore disciplinary perspectives on sustainability education, specifically examining main themes, pedagogical strategies, and implementation challenges across six key disciplines: engineering education, business and management education, humanities education, legal education, health sciences education, and teacher education. By analyzing these aspects, the review will highlight areas of convergence and divergence, thereby offering insights into best practices and guiding future directions for enhancing sustainability education across disciplines.

2. Methodology

This literature review adopts a qualitative, thematic approach to systematically examine disciplinary perspectives on sustainability education across undergraduate programs. The specific disciplines analyzed include engineering education, business and management education, humanities education, legal education, health sciences education, and teacher education. The review focuses explicitly on identifying and comparing main themes, pedagogical strategies, and

*Corresponding author: pttung@hcmiu.edu.vn

implementation challenges within and across these disciplines.

The literature search was conducted using major academic databases, including Scopus, Web of Science, Google Scholar, and ERIC, to identify peer-reviewed journal articles, books, book chapters, and relevant policy reports published between 2015 and 2025. The search terms included combinations of keywords such as "sustainability education," "higher education," "disciplinary perspectives," "engineering," "business and management," "humanities," "legal education," "health sciences," "teacher education," "pedagogical strategies," "curriculum integration," and "implementation challenges."

Articles were screened based on titles and abstracts to ensure relevance to undergraduate education, disciplinary perspectives, and one or more of the three categories (themes, pedagogical strategies, and challenges). Only publications specifically addressing these dimensions within the identified disciplines were included for further analysis. This approach aligns with established practices for conducting systematic thematic literature reviews (Grant & Booth, 2009).

The selected literature was analyzed using thematic content analysis, following guidelines proposed by Braun and Clarke (2012). Each publication was reviewed and coded based on three pre-defined analytical categories: (1) main sustainability themes emphasized within the discipline, (2) pedagogical strategies employed to teach sustainability, and (3) implementation challenges reported within the educational context. Codes were generated inductively within each category, allowing for detailed mapping of disciplinary similarities and differences.

Initially, discipline-specific data were summarized separately, followed by a comparative analysis across disciplines. This cross-disciplinary comparison highlighted commonalities and differences, facilitating an integrative understanding of how sustainability education manifests uniquely across academic fields. To ensure methodological rigor and validity, this review applied transparent inclusion criteria and maintained systematic documentation throughout the literature selection and analysis process (Petticrew & Roberts, 2008). Additionally, triangulation was applied by comparing findings across multiple studies within each discipline, enhancing reliability and depth of analysis (Creswell & Creswell, 2018).

This review explicitly narrows its scope to disciplinary perspectives within higher education contexts, thus excluding general sustainability education at primary, secondary, or vocational levels. Further, while the review aims for comprehensiveness, literature published outside the selected databases or non-English publications may be underrepresented, thus presenting potential limitations to generalizability.

3. Disciplinary Perspectives on Sustainability Education

Sustainability education in higher education takes on distinct contours in different academic disciplines. This section reviews how undergraduate programs across major fields incorporate sustainability, highlighting the themes emphasized, pedagogical strategies, curricular integration (core vs. elective), and unique challenges or innovations in each discipline. The literature from 2015–2025 reveals both common trends (e.g., growing awareness and student demand) and discipline-specific approaches to embedding sustainability into curricula.

A. Engineering Education

In engineering programs, sustainability integration is often driven by the field's relevance to infrastructure, energy, and environmental systems. Core themes include renewable energy, life-cycle assessment, green design, pollution reduction, and resource efficiency (Brundiers et al., 2021). While many engineering programs now feature at least one course on sustainable development, deeper integration throughout the curriculum remains a challenge (Mulder et al., 2015). Reviews show that learning outcomes often focus heavily on environmental dimensions, with social and ethical aspects underrepresented (Lozano et al., 2017).

Project-based learning is a widely used strategy in engineering sustainability education, often via capstone projects and industry collaborations. However, traditional lectures still dominate in many contexts (Cebrián et al., 2020). Instructors report difficulties in teaching interdisciplinary content within highly technical syllabi, and many cite a lack of sustainability training for faculty (Fischer & Barth, 2014). The EDINSOST project in Spain exemplifies progress by developing competency maps and curricular tools to support educators (Sánchez-Carracedo et al., 2018).

Barriers to integration include overloaded curricula, rigid accreditation requirements, and the lack of institutional incentives (Rose et al., 2020). Despite these constraints, many engineering faculties are piloting vertical integration—embedding sustainability topics across all years of study—and encouraging reflection on the broader social responsibilities of engineers (Wiek et al., 2011). The shift toward framing sustainability as a core professional competency is ongoing and uneven across institutions.

B. Business and Management Education

In business and management education, the past decade has seen increasing alignment with sustainability goals. Core topics include corporate social responsibility (CSR), sustainable finance, ethical leadership, and the triple bottom line (people, planet, profit) (Stubbs & Cocklin, 2008; Haertle et al., 2017). The UN's Principles for Responsible Management Education (PRME) initiative has led many schools to pledge sustainability integration, although implementation varies widely (Blasco & Murphy, 2017).

Pedagogically, business schools favor case-based learning, simulations, and experiential consulting projects. Many use sustainability cases to illustrate dilemmas and trade-offs in strategy, marketing, and operations (Berns et al., 2009). Yet a recurring critique is that sustainability content often remains marginal—taught in electives or brief modules—while core courses still emphasize profit maximization (Christensen et al., 2007). There is a risk of "greenwashing" in curricula where mission statements espouse sustainability without significant

curricular change (Haski-Leventhal et al., 2021).

Educators note that business students increasingly demand more integrated and values-driven content. Still, instructors face challenges shifting from economic models to systems thinking and critical reflection (Wals & Schwarzin, 2012). Progressive schools have introduced sustainability majors or certificates, and some embed sustainability learning outcomes in all business courses. Scholars call for deeper reform that aligns content, pedagogy, institutional mission, and faculty training (Leal Filho et al., 2019).

C. Humanities Education

In humanities disciplines such as literature, philosophy, history, and the arts sustainability education often centers on critical reflection, ethical inquiry, and cultural analysis. The rise of environmental humanities reflects efforts to connect ecological concerns with human values and narratives (Holm et al., 2015). Courses explore themes like environmental ethics, climate fiction, intergenerational justice, and historical responses to ecological change (Oppermann & Iovino, 2017).

Pedagogically, humanities programs use discussions, essays, and reflective writing to engage students in meaning-making. Literature courses may analyze climate-related novels; philosophy classes might debate ethical duties to future generations; and art courses promote sustainability communication through visual storytelling (Burke et al., 2017). These approaches help students develop moral reasoning and empathy key components of sustainability citizenship (Kagawa & Selby, 2010).

A frequent challenge is demonstrating practical impact. Yet research shows that narrative and creative methods can effectively shift environmental attitudes, particularly among non-science majors (McNeill, 2017). Humanities educators emphasize that cultivating imagination, compassion, and critical thinking is essential to motivating action and envisioning sustainable futures (Selby & Kagawa, 2015).

D. Legal Education (Law)

Law programs increasingly recognize sustainability as a cross-cutting issue. Traditional electives like environmental or international law are expanding to include climate law, sustainable development law, and rights of nature (González, 2015). There are growing calls to integrate sustainability into foundational courses such as property, torts, and constitutional law (Kotzé, 2017).

Law school's use case analysis, moot courts, and policy clinics to teach sustainability. Clinics give students hands-on experience with environmental advocacy, legislative drafting, and regulatory review (Saxena et al., 2019). Some institutions now frame law itself as a tool for sustainability training students to navigate legal systems in service of the SDGs (Pace, 2020).

Challenges include conservative curricula, crowded syllabi, and limited faculty expertise. However, student advocacy and evolving professional standards (e.g., American Bar Association recommendations) are pushing schools to embed sustainability more deeply (Kotzé & French, 2018). Scholars argue that all future lawyers must understand sustainability, regardless of specialization (González, 2015).

E. Health Sciences Education

In the health sciences, sustainability education has gained momentum through the frameworks of planetary health and sustainable healthcare. Medical and nursing students are now learning about the health impacts of climate change, air pollution, food systems, and social determinants of health (Myers et al., 2017). Public health programs incorporate sustainability in courses on environmental health, global health, and epidemiology.

Surveys reveal that students strongly support integrating sustainability, yet curricula often lag behind. For example, while most medical students acknowledge the relevance of climate change to health, few report receiving formal instruction (Wellbery et al., 2018). Reforms are emerging: in the UK, sustainable healthcare education is now a regulatory requirement (Mortimer et al., 2021).

Teaching strategies include clinical case studies with environmental components, disaster response simulations, and quality improvement projects aimed at reducing carbon footprints in hospitals (Salas et al., 2020). A key barrier is time constraints in already dense programs. Faculty development and interprofessional collaboration are seen as critical to advancing sustainability in health education (Gottlieb et al., 2020).

F. Teacher Education

Teacher education plays a pivotal role in scaling sustainability literacy. Programs grounded in Education for Sustainable Development (ESD) aim to develop future teachers' knowledge, pedagogical skills, and values for sustainability (UNESCO, 2017). Content areas include climate change, environmental justice, and global citizenship, taught through cross-disciplinary and active learning approaches.

Table 1
Sustainability education by discipline

Discipline	Main Themes	Pedagogical Strategies	Key Challenges
Engineering	Technical solutions, environmental systems, life-cycle design	Project-based learning, simulations, industry design challenges	Overloaded curricula, faculty readiness, lack of integration
Business & Management	CSR, SDGs, sustainable strategy, ethics	Case studies, consulting projects, values-based learning	Marginalization in core, traditional profit focus
Humanities	Environmental ethics, cultural narratives, eco-criticism	Critical discussion, reflective essays, narrative analysis	Demonstrating relevance, measuring outcomes
Law	Environmental law, climate law, rights of nature	Case law analysis, moot courts, legal clinics	Curricular conservatism, time constraints
Health Sciences	Planetary health, sustainable healthcare, climate-health links	Problem-based cases, disaster simulations, QI projects	Faculty expertise, crowded medical curricula
Teacher Education	ESD, systems thinking, teaching sustainability in K-12	Outdoor learning, cross-disciplinary planning, action research	Disciplinary silos, time, educator preparedness

Strategies include project-based learning, outdoor education, simulations, and reflective practice. Pre-service teachers are encouraged to design interdisciplinary lesson plans and conduct action research in schools (Evans et al., 2017). ESD competencies such as systems thinking, collaboration, and anticipatory thinking are emphasized throughout the curriculum (Rieckmann, 2018).

However, challenges persist: limited curriculum time, faculty readiness, and subject-matter silos often hinder integration (Mogren et al., 2020). Surveys show that teacher candidates value sustainability education but feel underprepared to teach it effectively (Anderson, 2019). Innovations such as sustainability-focused teaching practicums and whole-institution ESD models offer promising pathways.

4. Comparative Discussion of Sustainability Education by Discipline

The integration of sustainability into undergraduate education varies significantly across disciplines, yet there are notable commonalities as well as distinctive differences. This discussion explores similarities and differences among six key disciplines engineering, business and management, humanities, law, health sciences, and teacher education in three key areas: main themes, pedagogical strategies, and challenges.

A. Main Themes Across Disciplines

Across disciplines, certain sustainability themes, such as environmental awareness and ethical responsibility, consistently emerge. Engineering programs predominantly emphasize technical solutions to environmental challenges, such as renewable energy technologies, life-cycle analysis, and green infrastructure (Brundiers et al., 2021). Similarly, health sciences focus on environmental themes through the lens of planetary health, examining human health impacts arising from ecological degradation and climate change (Myers et al., 2017).

In contrast, business and management education frequently highlights corporate responsibility, ethical leadership, and sustainable financial practices, aligning closely with the triple bottom line (people, planet, profit) concept (Leal Filho et al., 2019). Humanities, by comparison, approach sustainability primarily through ethical reflection, cultural narratives, and critical analysis of human-environment interactions (Oppermann & Iovino, 2017). Law education addresses sustainability via regulatory and policy frameworks, examining climate law, environmental justice, and rights-based approaches to sustainability (Kotzé & French, 2018). Teacher education, meanwhile, integrates diverse sustainability topics within the comprehensive Education for Sustainable Development (ESD) framework, emphasizing systems thinking, social justice, and interdisciplinary knowledge (Rieckmann, 2018).

Thus, while all disciplines address sustainability, they differ notably in the specific themes emphasized: technical solutions dominate engineering and health sciences, ethical and cultural dimensions are central in humanities, regulatory frameworks prevail in law, and integrative educational strategies define teacher training.

B. Pedagogical Strategies Across Disciplines

Pedagogically, project-based learning emerges as a prominent approach, particularly in engineering and teacher education, emphasizing practical experience and real-world problem-solving. Engineering programs typically engage students in design challenges, simulations, and capstone projects to apply theoretical knowledge to practical sustainability solutions (Sánchez-Carracedo et al., 2018). Similarly, teacher education emphasizes experiential learning through projects, action research, outdoor education, and interdisciplinary lesson planning to equip future teachers with tools for effectively implementing ESD (Evans et al., 2017).

In business and management education, case studies and experiential learning methods such as consulting projects and sustainability-themed business competitions dominate. These pedagogies aim to develop strategic and critical thinking skills among business students, fostering an appreciation for the complexities and trade-offs inherent in corporate sustainability (Haski-Leventhal et al., 2021). Similarly, law education frequently employs case analyses, legal clinics, and moot courts to deepen students' practical understanding of sustainability-related legal frameworks (Kotzé & French, 2018).

Humanities and health sciences programs differ from the other disciplines by frequently utilizing reflective, dialogic, and critical pedagogies. Humanities education often employs literary analysis, philosophical debates, and creative projects to foster critical reflection on values and ethics related to sustainability (McNeill, 2017). In health sciences, problem-based learning scenarios and clinical case studies are prevalent, directly linking health impacts with sustainability issues and enabling students to reflect on sustainable healthcare practices (Gottlieb et al., 2020).

Overall, while project-based and experiential learning are common, business and law emphasize real-world case studies, humanities and health sciences prioritize reflective and critical methods, and engineering and teacher education focus heavily on hands-on, practical experiences.

C. Implementation Challenges Across Disciplines

Despite disciplinary differences, common challenges in sustainability integration are evident, particularly relating to faculty expertise, curricular overcrowding, and interdisciplinary barriers. Faculty competence and readiness consistently emerge as significant hurdles across disciplines. Engineering and health sciences instructors often lack the interdisciplinary training needed to confidently teach sustainability concepts (Rose et al., 2020; Wellbery et al., 2018). Similarly, business and law educators frequently report limited exposure or expertise in the broad, integrative aspects of sustainability, making effective teaching challenging (Haski-Leventhal et al., 2021; Kotzé & French, 2018).

Curricular constraints represent another common challenge. Dense, accreditation-driven curricula in engineering, law, and health sciences leave little room for sustainability content. Educators in these disciplines often perceive sustainability as competing with traditional technical or professional content, complicating its integration (Mulder et al., 2015; Mortimer et

al., 2021). Business schools similarly struggle with embedding sustainability beyond elective or specialized courses, given prevailing market-driven educational models that prioritize profit-oriented teaching (Christensen et al., 2007).

Teacher education and humanities face somewhat different, though related, curricular challenges. In teacher education, the primary issue is curricular fragmentation, due to disciplinary silos and crowded teacher training requirements, making coherent integration of sustainability across subjects difficult (Mogren et al., 2020). Humanities programs, while less constrained by rigid accreditation, face skepticism about their tangible contributions to sustainability outcomes, leading to struggles in demonstrating relevance and measurable impact (Selby & Kagawa, 2015).

Therefore, while faculty expertise and curricular space are widespread challenges, the specific nature of these challenges differs according to disciplinary context: professional programs (engineering, law, health sciences) face structural accreditation constraints, business education confronts market-driven curricular models, and humanities and teacher education encounter barriers of disciplinary silos and perceived relevance.

5. Future Directions for Further Research

The comparative analysis of sustainability education across various disciplines highlights several promising avenues for further research. Future studies could explore effective models for integrating sustainability across disciplinary boundaries, such as interdisciplinary curriculum frameworks or shared pedagogical approaches. Although some fields, such as teacher education and engineering, actively incorporate interdisciplinary projects (Evans et al., 2017; Sánchez-Carracedo et al., 2018), research examining the outcomes and long-term impacts of these integrative models is limited. Investigating interdisciplinary teaching strategies could illuminate best practices applicable across diverse academic programs.

Despite widespread use of pedagogies like project-based learning, simulations, and reflective practices across disciplines (Brundiers et al., 2021; Haski-Leventhal et al., 2021), comparative studies examining their relative effectiveness remain scarce. Future studies should empirically evaluate these pedagogies, measuring outcomes such as sustainability literacy, critical thinking skills, and long-term behavioral change. Understanding the effectiveness of different pedagogical strategies can inform curriculum design and teacher training.

In addition, faculty readiness consistently emerges as a significant challenge across disciplines, affecting sustainability integration in undergraduate programs (Mortimer et al., 2021; Rose et al., 2020). Future research could focus on identifying effective faculty development programs or institutional practices that equip educators with essential sustainability competencies. Investigating how faculty attitudes, competencies, and training influence the depth of sustainability integration would be valuable for institutional policy development.

Curricular overcrowding and institutional constraints are recurrent challenges in embedding sustainability education (Mulder et al., 2015; Mogren et al., 2020). Future research should explore institutional frameworks and governance strategies that successfully support curricular reform, including adjustments to accreditation requirements and institutional incentives for sustainability integration. Studies examining case examples of successful curricular transformations could offer valuable insights for widespread implementation.

Moreover, assessing the effectiveness of sustainability education, especially across varied disciplinary contexts, remains challenging (Wiek et al., 2011). There is a clear need for further research to develop valid and reliable assessment tools capable of evaluating sustainability competencies across disciplines. Investigating how sustainability outcomes such as systems thinking, ethical reasoning, or sustainable professional practices can be effectively assessed would enhance accountability and provide clearer benchmarks for improvement.

Finally, longitudinal research tracking student cohorts post-graduation could offer crucial insights into the long-term impacts of sustainability education. Studies that evaluate how sustainability training influences graduates' professional choices, behaviors, and attitudes toward sustainability in their careers would provide valuable feedback for educational programs (Gottlieb et al., 2020; Wellbery et al., 2018). Such longitudinal data could also strengthen arguments for sustained institutional investment in sustainability education.

6. Conclusion

This literature review has examined how sustainability education is approached across six key undergraduate disciplines: engineering, business and management, humanities, law, health sciences, and teacher education. The findings demonstrate that while there is broad consensus on the importance of sustainability in higher education, the ways in which it is taught, framed, and implemented vary significantly across disciplinary contexts. These differences reflect not only the epistemological foundations of each field but also the specific professional competencies and societal roles each discipline prepares students to fulfill.

Despite disciplinary distinctions, the review reveals several overarching patterns. A recurring theme across all fields is the growing emphasis on environmental responsibility and ethical engagement. However, the expression of these themes differs: engineering education tends to highlight technical innovation and systems thinking; business and management focus on ethical leadership, corporate responsibility, and sustainable strategy; humanities foreground moral reflection, cultural critique, and ecological imagination; legal education explores regulatory frameworks and justice-based approaches; health sciences emphasize planetary health and the intersection between ecological and human well-being; and teacher education prepares future educators to embed sustainability into primary and secondary school curricula through holistic, transformative pedagogy.

In terms of pedagogy, active and student-centered learning approaches are widely adopted, although the specific methods vary. Project-based and experiential learning are particularly

prominent in engineering, teacher education, and health sciences. Business and law make extensive use of case-based instruction and real-world simulations, while the humanities rely on reflective, dialogic, and creative pedagogies to foster critical consciousness and ethical sensitivity. What unites these approaches is the belief that sustainability cannot be effectively taught through passive instruction alone but must engage learners in authentic, contextualized, and value-rich experiences.

The review also highlights shared challenges across disciplines. These include limited faculty expertise in sustainability, the overcrowding of existing curricula, and difficulties in achieving meaningful interdisciplinary integration. However, each discipline experiences these challenges in distinctive ways. For instance, professional programs such as engineering and health sciences often struggle to fit sustainability into rigid, accreditation-driven curricula. In business education, tensions arise between sustainability values and market-driven teaching models. In the humanities and teacher education, challenges often relate to marginalization, siloed structures, and the perceived lack of instrumental value compared to more technical subjects.

What emerges from this analysis is a clear recognition that sustainability education is both necessary and inherently multifaceted. Each discipline brings valuable perspectives and practices to the table, and no single approach can address the complexity of sustainability alone. The future of sustainability education lies not in standardizing content across disciplines, but in fostering meaningful dialogue and collaboration among them. Engineering and health sciences contribute technical knowledge and real-world applications; the humanities and law deepen ethical reasoning and critical analysis; business and teacher education promote organizational and systemic thinking. Together, they offer a more complete and transformative vision of sustainability learning.

Looking ahead, further research is needed to support this vision. There is a particular need to investigate how interdisciplinary teaching models can be developed and sustained within institutional settings, how pedagogical innovations affect student outcomes across diverse fields, and how faculty development can be strengthened to support sustainability integration. Moreover, longitudinal studies tracking the long-term impact of sustainability education on graduates' careers, behaviors, and civic engagement would provide valuable evidence to guide future educational strategies.

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