



Innovation and Sustainability: A Multidisciplinary Research Perspective

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Abstract

Universities are expected to prepare graduates who can respond to interconnected environmental, social, and economic problems, and this expectation has pushed sustainability education toward considerable innovation. This narrative review examines recent literature, mainly from 2023 to 2025, on how innovation in education for sustainable development is conceptualised, implemented, and evaluated, with attention to higher education and to evidence that crosses disciplinary boundaries. Three clusters of innovation are discussed: competence-based curriculum frameworks, experiential pedagogies such as service-learning, and whole institution approaches that align teaching with governance and campus practice. Evidence from systematic reviews and meta-analyses suggests that sustainability education reliably improves knowledge, produces smaller gains in attitudes and behaviour, and works best when learning is active and action-oriented. However, much of the strongest quantitative evidence comes from school settings, impact evaluation in universities remains thin, and implementation is hampered by limited educator capacity, funding, and fragmented institutional commitment. The paper argues that innovation should be judged by its coherence, its evaluability, and its capacity to cross disciplines, and it identifies research priorities for higher education.

Keywords: Sustainability education, innovation, higher education, sustainability competences, service-learning, whole institution approach

Introduction

Few ideas have travelled as widely through education policy as the claim that learning must change if societies are to become more sustainable. Within the 2030 ^[7] Agenda, quality education is framed not only as a goal in itself but as a lever for the other goals, and universities are expected to contribute through teaching, research, operations, and community engagement (Hinduja *et al.*, 2023) ^[3]. That expectation has encouraged what might loosely be called innovation: new ways of defining what graduates should be able to do, new teaching formats, and new ways of organising institutions.

The terms innovation and sustainability are, however, easily paired without being examined. Novelty is not a virtue in itself, and a practice that is new to one institution may be long established elsewhere. A multidisciplinary perspective is useful because sustainability problems do not respect the boundaries of academic departments, and because the evidence on how to teach for them is scattered across education, environmental psychology, management, engineering, and sustainability science. This paper therefore asks three questions. Which innovations in sustainability education are most prominent in recent literature? What does synthesised evidence say about whether they work? And what stands in the way of putting them into practice? The focus is higher education, although some of the most rigorous quantitative evidence comes from schools and is used here with that limitation in mind.

Review Approach

This is a targeted narrative review rather than a full systematic review. Searches were run in October 2026 through web-based discovery of publisher platforms, open-access repositories, and indexing pages, using combinations of terms such as education for sustainable development,

higher education, sustainability competences, service-learning, whole institution approach, systematic review, and meta-analysis. Priority went to systematic reviews, scoping reviews, and meta-analyses published from 2023 onward, because these consolidate many primary studies at once. One influential earlier review from 2021 was retained for its role in defining competence frameworks. Sources were included when they addressed sustainability education directly and when their abstracts or full texts could be verified online. Eight sources met these conditions, one of them published in German. Because the search did not use formal bibliographic databases with documented screening, relevant studies may be missing, and the findings are best read as an informed synthesis rather than an exhaustive account.

Major Approaches to Innovation in Sustainability Education

Competence-Based Frameworks

A first line of innovation shifts the question from what students should know to what they should be able to do. Redman and Wiek (2021) ^[6] screened thousands of publications and retained more than 270 peer-reviewed articles to build a unified framework. They reported substantial agreement among scholars and proposed eight key competences: five long-established ones plus three newer additions covering intrapersonal, implementation, and integration capacities, all intended to sit alongside disciplinary and professional skills. Because the framework is meant to apply across fields, it offers a shared vocabulary for programmes in engineering, business, education, and the sciences.

Later work suggests the consensus travels beyond universities. A scoping review of secondary-school research covering 2003 to 2023 found broad agreement that critical

thinking, systems thinking, and action competence are central capabilities, while also noting that the literature leans heavily toward Europe, especially Germany and Sweden (Sposab & Rieckmann, 2024) ^[8]. Competence thinking therefore appears robust, but its geographical concentration is a reminder that definitions developed in one context may not be neutral elsewhere.

Experiential Pedagogies and Service-Learning

A second cluster concerns how competences are developed. Service-learning, in which coursework is tied to community service, has attracted particular attention. A review that combined analysis of United Nations documents with a systematic review of academic literature concluded that service-learning programmes match most components of UNESCO's education for sustainable development framework (Álvarez-Vanegas *et al.*, 2024) ^[2]. The authors described service-learning as a niche innovation, meaning a practice that shows promise at the margins but has not yet reshaped mainstream teaching.

A similar message emerges from broader syntheses of pedagogy. A review of international meta-analyses on environmental education found that active, action-based learning, modelling, goal setting, personal commitment, varied activities, and nature experiences were among the elements linked to better outcomes (Nachbauer, 2024) ^[5]. The practical implication is that innovation lies less in any single technique than in designing learning that is participatory, applied, and connected to real problems that no single discipline can solve alone.

Whole Institution Approaches

The third cluster treats the institution itself as the object of innovation. Holst (2023) ^[4] analysed 104 scientific and grey-literature documents and described whole institution approaches as continuing, participatory learning processes aimed at coherence between what an institution teaches and how it behaves, linking formal and hidden curricula. The synthesis identified five principles (coherence, continuous learning, participation, responsibility, and long-term commitment) and seven areas of action: governance, curriculum, campus, community, research, communication, and capacity building.

The appeal of this model is that it addresses a familiar contradiction, in which a university teaches sustainability while its procurement, energy use, or reward systems suggest otherwise. It also demands cooperation across departments, which makes it multidisciplinary by design. Whether it produces better learning outcomes is a separate question that a conceptual synthesis was not designed to answer.

Evidence on Effectiveness

Evidence on effectiveness is uneven across the three clusters. The most precise estimates come from meta-analytic work on school-level climate education. Aeschbach *et al.* (2025) ^[1] pooled 53 intervention studies drawn from 6,159 records and reported a medium to large average effect on knowledge ($g = 0.77$), but smaller effects on attitudes ($g = 0.39$) and behaviour ($g = 0.36$). They also found signs of publication bias in the knowledge results, very high heterogeneity, and generally modest study quality, and they cautioned against drawing firm practice recommendations. Their sample covered primary and secondary pupils only, so

the figures cannot be transferred automatically to university students.

For higher education, the available syntheses are mainly descriptive. A review of 63 articles on the Sustainable Development Goals in universities during the first five years of Agenda 2030 ^[7] mapped research trends, methods, and tools, and ended with barriers and limitations rather than effect sizes (Solís-Espallargas *et al.*, 2023). The service-learning review likewise called for impact evaluation focused on sustainability competences (Álvarez-Vanegas *et al.*, 2024) ^[2]. Taken together, the evidence suggests that sustainability education can raise understanding with reasonable confidence, that changing attitudes and conduct is harder, and that rigorous testing of university-level innovations has lagged behind their adoption. A cautious reading is therefore that the case for these innovations currently rests on plausibility, alignment with theory, and early review evidence rather than on strong causal tests.

Barriers and Challenges to Implementation

Syntheses converge on a similar set of obstacles. Service-learning reviews identify insufficient educator capacity, limited funding, and unsupportive educator attitudes as the principal challenges, and they stress that unless educators are trained and incentivised, neither service-learning nor wider sustainability education is likely to transform learning environments (Álvarez-Vanegas *et al.*, 2024) ^[2]. A systematic review of Pakistani higher education reached comparable conclusions: shortages of funding, awareness, and trained staff, together with weak commitment and hierarchical structures in public universities, slowed progress (Hinduja *et al.*, 2023) ^[3]. That review also noted lower sustainability awareness among students in many fields and a research base concentrated in urban areas of two provinces.

Other barriers are conceptual and methodological. Holst (2023) ^[4] observed that questions remain about how whole institution approaches should be specified, even though their central aim is widely accepted. Evidence quality is a further constraint: Aeschbach *et al.* (2025) ^[1] described the methodological quality of many primary studies as low, and research on competences is geographically concentrated (Sposab & Rieckmann, 2024) ^[8]. These problems plausibly reinforce one another, since institutions with limited resources are the least able to produce the evaluation that would justify further investment.

Discussion and Implications

Read together, the sources suggest that innovation in sustainability education should be judged by three tests rather than by novelty. The first is coherence: whether teaching, assessment, and institutional behaviour point in the same direction, as whole institution thinking insists (Holst, 2023) ^[4]. The second is evaluability: whether an innovation is designed so that its effect on defined competences can be measured, a gap repeatedly noted in the university literature. The third is transferability across disciplines, where shared competence frameworks (Redman & Wiek, 2021) ^[6] can help programmes in different fields compare aims without erasing their differences. Framed this way, innovation becomes a question of design quality and institutional follow-through rather than of adopting the newest label, and it can be assessed with the same scepticism applied to any other educational reform.

For practitioners, the implications are fairly concrete. Staff development and incentives appear to be preconditions rather than optional extras. Experiential methods such as service-learning are promising, but the reviewed evidence points to local problems and community partnerships as the way to make them visible and workable (Álvarez-Vanegas *et al.*, 2024) ^[2]. Expectations should also be realistic: if knowledge gains are easier to achieve than behavioural change, programmes that aim at action need explicit practice opportunities and not only content. For researchers, priorities include controlled evaluations in university settings, validated measures in place of ad hoc instruments, and syntheses that cover under-represented regions and disciplines, including the social sciences (Aeschbach *et al.*, 2025) ^[1]. A limitation of this paper is its modest evidence base, assembled through a non-systematic search, so its conclusions are indicative rather than definitive.

Conclusion

Recent literature portrays sustainability education as a field rich in innovation but short on proof. Competence frameworks, experiential pedagogies, and whole institution approaches each offer a credible response to the challenge of preparing graduates for interdependent problems, and they complement one another more than they compete. The strongest synthesised evidence shows dependable gains in knowledge and more modest change in attitudes and behaviour, with most of that evidence drawn from schools. The central task for higher education is therefore not to generate further novelty but to embed what is promising, equip educators to deliver it, and evaluate it rigorously across disciplines and regions. Progress will depend as much on sustained institutional support as on pedagogical creativity.

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