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Integrating Biodiversity Conservation Education into Higher Learning for Promoting Ecological Knowledge and Sustainable Practices

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Abstract

While the loss of biodiversity is accelerating due to habitat degradation, climate change and unsustainable use of resources, higher education institutions (HEI) have been slower to incorporate biodiversity content in subjects other than those focused on the environment and biology. This study involved the incorporation of a structured education module on biodiversity conservation in the general undergraduate curriculum and its impact on students' ecological knowledge, conservation attitudes, environmental awareness, and intention to sustain their behaviour. A quasi-experimental single-group pre-test/post-test design was used with a total of 240 undergraduate students who were sampled from a variety of academic disciplines throughout a single academic semester. The intervention was classroom-based, involved the use of digital learning resources, an audit of biodiversity on the campus and community-based field experience, and was based on the conceptual framework for curriculum integration. Data were gathered using validated Likert scale questionnaires before and after the intervention, and the data were analyzed using paired sample

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comparisons. The results show statistically significant improvements in all dimensions measured, most notably in ecological knowledge (44.1% increase) and environmental awareness (40.3% increase), and an overall composite score increase of 38.4%. The results indicate that, in the case of university students who are not biodiversity specialists, the deliberate design and experience of biodiversity education can have a measurable impact on both cognition and orientation. It is concluded that integrating the ecological dimension into the curriculum at the institutional level is more feasible for developing ecological literacy and sustainable practices in higher education, as opposed to incorporating it as an optional subject. Curriculum implications and future research are explored.

Keywords:

Biodiversity conservation, higher education, ecological literacy, curriculum integration, sustainable development, environmental education, behavioral intention.

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Introduction

The loss of biodiversity around the world is at an unprecedented rate, and land use change, overexploitation, pollution and climate change are the main threats to biodiversity and species and habitat loss (Boeve-de Pauw et al., 2015; Volkmann & Fraunhofer, 2023). International agreements have always advocated the integration of ecological knowledge into the mainstream of formal education systems, but most teaching on ecology and conservation is carried out in dedicated courses of ecology, biology and environmental sciences, with little well structured provision of biodiversity related knowledge in other undergraduate programmes (Khalikova et al., 2024; Ashtiani et al., 2015). Higher education institutions sit in a unique place in this context: They educate those who will be making environmental decisions in the future for many decades, and they have pedagogical infrastructure to link cognitive learning with the field-based learning that is essential to environmental decision making (Zhang & Cao, 2025; Obrecht et al., 2022). With the rise of sustainable development in the education agenda, universities are being urged to look beyond education for a single course in SD to thinking about SD issues across the curriculum and linking the ecological knowledge to the choices made in everyday life (Mulà et al., 2017).

Although the policy was adopted by most institutions, most institutions also teach sustainability topics as stand-alone elective courses, resulting in an uneven exposure of students and a negligible effect on the level of knowledge or behavior change of students (Pinto et al., 2025). The other barrier is that environmental knowledge does not always correspond to action for the environment, as has been previously documented and instruction is not always enough to 'get' sustainable action (Radhakrishnan et al., 2026; Öztürk & Pizmony-Levy, 2025). Few empirical studies assess multi-component, structured biodiversity curricula that integrate classroom learning, with field-based and community-based learning, and even fewer that report on pre- and post-intervention outcomes in knowledge, attitudes and behavioral intentions simultaneously (Tsioumani, 2020). This lack of evidence restricts the potential for curriculum designers to make the case for a school's investment in biodiversity education on the basis of evidence, not assumption.

There are three contributions to the literature made in this study. First, it suggests a conceptual model to integrate Biodiversity Conservation Education into the general higher education curriculum, which connects the three-step process of needs assessment, curriculum design, and student learning experience with the one-step process of teaching. Second, it offers empirical pre-test/post-test evidence of performance over four complementary outcome dimensions (ecological knowledge, conservation attitude, environmental awareness, and sustainable behavioral intention), with a multi-disciplinary undergraduate sample, not one that was biology specific. Third, it provides practical advice and guidance to those involved in curriculum design and institutional policy-making who want to incorporate biodiversity literacy in a scalable and non-specialist way in higher education.

This paper is organized in the following manner: Materials and methods are described in Section 2, which outlines the study design, participants, and the structure of the intervention, as well as the conceptual framework to be used for the curriculum integration. In Section 3, the results and discussion are presented, which are tabulated pre- and post-intervention outcomes, and a comparative graphical analysis. Finally, implications, limitations and future research are presented in section 4.

Materials and Methods

Quasi-experimental, single-group pre-test/post-test design was used to assess the effect of the curriculum-integrated biodiversity conservation education on undergraduate students. The participants consisted of 240 undergraduate students (mean age 20.4 years) from five disciplines that were not related to biology, which were sampled using a stratified sampling method with representation across academic years. Four components of instruction were implemented: (i) classroom lectures and seminars that introduced the concept of ecosystem services, drivers of species loss, and local biodiversity case studies; (ii) curated digital learning resources such as short documentaries and interactive species mapping activities that students completed; (iii) two guided biodiversity audits—one in the classroom and one in the community—in which students enumerated local flora and fauna; and (iv) a final community-based conservation service project.
The instructional design was structured around the conceptual framework in figure 1 which was organized as a closed instructional cycle that started with a baseline assessment of needs and culminated with measurable outcomes in regards to the ecological knowledge and sustainable practices. It was planned to integrate the experiential elements with a lasting ecological literacy by means of this cyclical approach instead of a single lecture series, rather than using the latter as a sole approach. It was not planned to use a single lecture series as the sole approach, but to combine the cognitive with the experiential elements of ecological literacy with a cyclical structure (Shrirao & Mishra, 2025). A validated, 24-item, 5-point Likert scale questionnaire that measures four constructs: ecological knowledge, conservation attitude, environmental awareness, and sustainable behavioral intention was used for data collection at baseline (pre-test) and endline (post-test). All subscales were found to be reliable prior to administration (Cronbach's alpha > 0.80). Pre-post differences were assessed on each construct by using paired-sample statistical comparisons and set at $p < 0.05$.

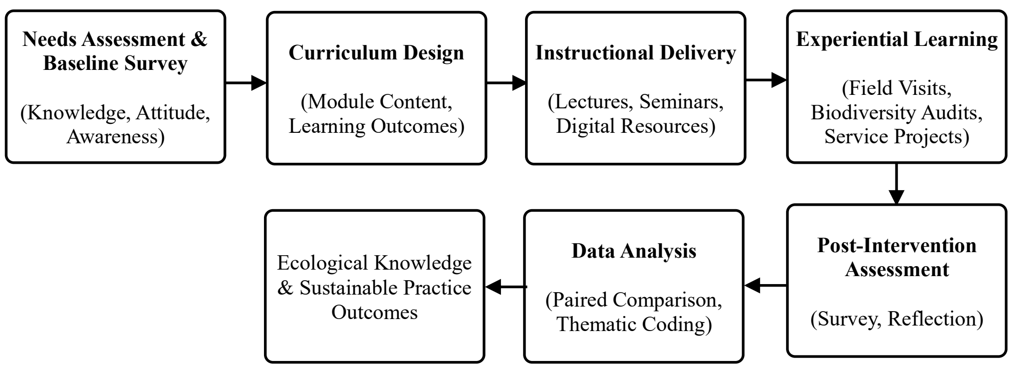

Figure 1. Conceptual framework for integrating biodiversity conservation education into the higher-education curriculum.

The study received ethical clearance from the institutional research ethics committee before recruitment, and students were made aware of and offered the opportunity to consent to participation. The confidentiality of the students was preserved with anonymous responses being coded and students had the option to drop out of the study at any time with no academic consequences. The pre- and post-intervention surveys were scored into a structured spreadsheet, checked for completeness, and then analyzed using standard statistical software. Pre- and post-test scores of the four constructs were compared using paired sample t-tests and for the composite score, descriptive statistics (mean, standard deviation, percentage improvement) were calculated. Throughout, the significance level was set at $p<0.05$ as is typical in education-intervention research.

Results and Discussion

Table 1 presents pre- and post-intervention mean scores for each of the four dimensions and the composite score. A statistically significant improvement was observed after the intervention on all dimensions ($p < 0.001$), with the largest relative improvement found for ecological knowledge (44.1%) and the smallest relative improvement for sustainable behavior intention (35.4%). The overall composite score increased by 38.4%, suggesting that the increase was not limited to factual recall, but occurred across cognitive, affective and behavioral domains.

Table 1. Pre- and post-intervention mean scores across assessed dimensions (N = 240)

Dimension	N	Pre-test Mean (SD)	Post-test Mean (SD)	% Improvement	p-value
Ecological Knowledge	240	2.86 (0.54)	4.12 (0.41)	44.1%	< 0.001
Conservation Attitude	240	3.21 (0.48)	4.35 (0.39)	35.5%	< 0.001
Environmental Awareness	240	3.05 (0.51)	4.28 (0.36)	40.3%	< 0.001
Sustainable Behavioral Intention	240	2.94 (0.57)	3.98 (0.44)	35.4%	< 0.001
Overall Composite Score	240	3.02 (0.44)	4.18 (0.33)	38.4%	< 0.001

These are shown graphically in figure 2, and each of the five measured categories shows a regular increase throughout. The figures reveal a visual contrast, with the gains in ecological knowledge and environmental awareness being proportionately higher than the gains in behavioural intention, which is similar to the pattern of results found in previous studies that showed that it generally takes more than one cycle of instruction to translate ecological knowledge into changes in behaviour (Radhakrishnan et al., 2026).

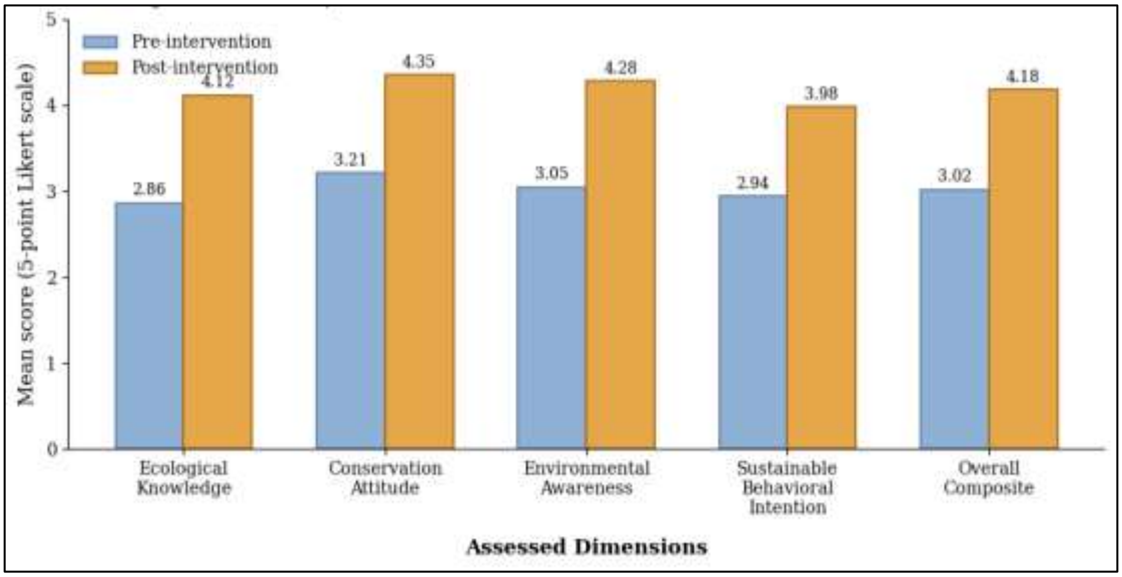

Figure 2. Pre- and post-intervention mean scores across assessed dimensions (N = 240)

These results corroborate recent research showing that experiential and community-embedded elements better enhance the effectiveness of sustainability-focused curricula compared to classroom teaching in comparable undergraduates in different institutional settings (Abdullahi et al., 2024). This finding is in line with the general conclusion that sustainable development education is best seen as a progressive, ongoing development program over time, and not just a one-semester course (Díaz & Malhi, 2022). In practice, the results indicate that "experiential" learning elements (field audits and community projects) should not be seen as "enrichment" activities, but rather as integral parts of the process by which cognitive achievement is translated into behavioral orientation. Additionally, the multiscientific nature of the sample suggests that these effects could be reproduced in the general curriculum, not just in certain departments, which in turn is a sign of the possibility of such integration.

The pattern of scores for the subscales in table 1 also provides diagnostic information for curriculum refinement. Given that the increase in ecological knowledge was relatively large, the intervention's classroom and digital resource elements seem to be effective in delivering factual and conceptual information; however, the relatively small increase in behavioral intention indicates that a persistent attitude–behavior gap may exist that could not be easily bridged by the intervention's instructional components. This phenomenon follows the general trend of the sustainability-education literature, where changes in knowledge are the most easily achieved and changes in behaviour are the most difficult to change in the short term (Asencio et al., 2026). Thus, institutions interested in bridging this gap may require an on-going support strategy, including campus sustainability efforts, peer mentoring, or ongoing community partnerships that build on the engagement that is observed in this study and extends beyond the one-semester period. The findings together indicate that learning about biodiversity should be seen as an integrated institutional commitment that permeates the students' entire learning journey.

Conclusion

This study focused on the incorporation of a structured biodiversity conservation education module in the general undergraduate curriculum and the impact it had on ecological knowledge, conservation attitudes, environmental awareness and sustainable behavioral intention of the undergraduate students. Changes in 240 multidisciplinary undergraduate students were assessed in both pre- and post-tests, with statistically significant increases observed in all dimensions with the highest gains in ecological knowledge and environmental awareness and a comparatively more modest, but still significant, increase in behavioral intention. The findings in this study are congruent with the proposition that it is best to promote biodiversity literacy through curriculum-wide integration of classroom-based, field-based and/or community-based learning, as suggested in the international guidance for education for sustainable-development. The results have implications for higher education institutions looking for scalable approaches to integrate ecological knowledge and sustainable practices into all of their education and activities. The study has been limited in design (a single institution, single-semester) and the lack of a non-intervention control group, which limits the degrees of causation and generalizability. Future studies should use multi-institutional, longitudinal designs with control groups to evaluate the longevity of behavior change over time and determine which of the various aspects of the lesson are most predictive of continued pro-environmental behavior after graduation.

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