Evaluating e-learning for Environmental Education

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Abstract

COVID-19 has changed the learning atmosphere as educational activities have to adapt to highly restricted conditions. Distance or e-learning has been broadly implemented, including university environmental education learning. This research evaluates the implementation of e-learning in environmental education at the university level. It used a descriptive method by applying a survey technique. The researchers selected 224 students as the sample. A questionnaire consisting of 10 questions related to e-learning implementation was the chosen instrument. The results demonstrate that: 1) the most widely applied media is Google Meet (46.43%), 2) 53.57% of students agree that online-based tests are more accessible compared to offline ones, and 3) the most significant obstacle is insufficient internet quota (53.13%). The findings imply that e-learning is a viable tool to maintain educational activities during this pandemic. Furthermore, students reported a need for more robust online assessment practices that can support and, where appropriate, assess environmental education outcomes (e.g., knowledge, attitudes, and intended behaviors).

Keywords: E-learning evaluation, Environmental education, COVID-19, Higher education

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The Context of E-Learning in Higher Education

Since early 2020, the COVID-19 pandemic has required higher education institutions worldwide to shift rapidly from face-to-face instruction to emergency remote teaching. This transition expanded the use of e-learning platforms for content delivery and assessment; however, the quality, equity, and effectiveness of implementation have varied substantially across contexts (Day et al., 2020; Wargadinata et al., 2020).

In this context, universities were compelled to redesign learning materials, communication routines, and assessment practices for online delivery. Systematic evaluation of e-learning implementation is therefore essential to identify constraints (e.g., connectivity, device access, and learning conditions at home) and to improve alignment between instructional design and course objectives (Hidayati & Wuryandari, 2012).

Recent developments in higher education have reinforced the need to distinguish planned online education from the rapid 'emergency remote teaching' adopted during crises. Emergency remote teaching is typically a temporary, pragmatic shift aimed at maintaining instructional continuity, whereas high-quality online learning is intentionally designed around pedagogy, interaction, assessment, and learner support (Hodges et al., 2020). This distinction matters for interpretation because crisis-time course delivery often prioritizes speed and access over instructional design, which can depress engagement and learning quality even when digital infrastructure is available. In this respect, evaluations of e-learning should attend to design intentionality and to the extent that online delivery includes structured opportunities for interaction, feedback, and iterative improvement, rather than functioning as a simple content repository.

The COVID-19 period nevertheless accelerated a longer-term institutional transition toward flexible, hybrid, and blended models across higher education. Evidence from an international student survey suggests that students' experiences in this transition were shaped not only by platform functionality but also by workload, emotional wellbeing, financial constraints, and access to stable connectivity and devices (Aristovnik et al., 2020). Equity-focused analyses of emergency remote teaching similarly highlight that the 'online turn' can reproduce or amplify existing inequalities unless teaching and support structures explicitly address access, accessibility, and digital capability (Czerniewicz et al., 2020). These findings imply that evaluations of e-learning should be situated within institutional conditions (technical, social, and economic) rather than treating technology as a neutral channel.

Meta-analytic research provides an important baseline for contextualizing these changes. A U.S. Department of Education synthesis of controlled studies reports that, on average, learning outcomes in online or blended conditions are at least comparable to face-to-face instruction, and that blended or hybrid formats often show an advantage when they add meaningful learning time, structure, or interaction rather than merely shifting lectures to a platform (Means et al., 2009). Complementary comparative work in higher education also concludes that distance education is not inherently inferior; instead, outcomes vary widely and are strongly conditioned by pedagogical and methodological features (Bernard et al., 2004). Consequently, the key question is not whether e-learning 'works' in general, but which design

features and learning conditions produce robust learning for specific goals and learner populations.

From a theoretical standpoint, models such as the Community of Inquiry framework conceptualize effective online learning as an interaction among teaching presence (course design, facilitation, and direct instruction), social presence (a climate that enables purposeful and trusting communication), and cognitive presence (sustained meaning-making through inquiry) (Garrison et al., 2000). This lens is useful for interpreting learning in complex, value-laden domains such as environmental education, where learners benefit from dialogic sense-making, evidence-based argumentation, and reflective integration of knowledge with values and action. Building on such theoretical models, recent scholarship on online university teaching during and after the COVID-19 crisis emphasizes the need for purposeful activity design, scaffolding of reflection, and alignment between learning activities and assessment (Rapanta et al., 2020).

At the course level, engagement becomes a central quality indicator because engagement mediates both persistence and learning in online contexts. Research on students' perceptions of engagement strategies suggests that instructor presence, timely feedback, and purposeful peer interaction are perceived as particularly influential, often more so than superficial 'activity' within a learning management system (Martin & Bolliger, 2018). Engagement is therefore not synonymous with frequency of logins or time-on-task; rather, it reflects learners' sustained cognitive and social investment in learning tasks. For evaluation purposes, this implies that measures of e-learning quality should include not only technical usability and content delivery, but also perceived interaction quality, clarity of expectations, and the extent to which tasks require learners to apply concepts, collaborate, and reflect.

Taken together, contemporary research positions e-learning as a socio-technical learning ecosystem: technologies matter, but their educational value depends on pedagogical coherence, inclusivity and accessibility, learner support structures, and constructive alignment among outcomes, activities, and assessment. For this reason, the present study treats e-learning as an integrated set of design and enactment features within higher education and evaluates both the learning experience and the perceived learning value of e-learning for environmental education. This framing also supports actionable interpretation because it helps connect evaluation findings to specific course-design decisions that can be revised and improved over time (Golitsyna, 2017; Gündüz et al., 2016).

Research Gap and Environmental Education Objectives

Stakeholders in higher education must critically evaluate the implementation of e-learning, particularly its role in fostering environmental consciousness. Despite the escalating environmental degradation observed over the past decade, there is a notable research gap in how e-learning frameworks specifically integrate and evaluate environmental education at the university level. Current evaluations often prioritize technical proficiency and general academic performance, while overlooking the cultivation of students as "agents of change" for ecological sustainability (Arantes do Amaral & Rodrigues Lino dos Santos, 2018; Stover & Ziswiler, 2017; Al Sultan et al., 2018). This study aims to bridge this gap by examining the extent to which e-learning modules across various faculties incorporate environmental protection values.

This evaluation can assist stakeholders in identifying obstacles that can be addressed in the short, medium, and long term. Moreover, it maps students' perceptions and experiences during the implementation of e-learning. Prior research conducted during the COVID-19 pandemic suggests that online learning required rapid adjustment and continuous improvement (Allo, 2020; Erduran, 2020; Flores & Swennen, 2020; Sintema, 2020). Therefore, there is a clear need to evaluate e-learning implementation in university-level environmental education during the pandemic.

In the field of environmental education, the role of higher education is increasingly framed through Education for Sustainable Development (ESD), which emphasizes the development of competences for addressing sustainability challenges rather than the transmission of environmental facts alone. The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2020) ESD for 2030 roadmap positions education as a lever for enabling learners to make informed decisions and act responsibly for environmental integrity, economic viability, and a just society (UNESCO, 2020). Similarly, the Berlin Declaration calls for integrating sustainability principles across curricula and learning environments and for strengthening action-oriented learning pathways that connect knowledge to practice (UNESCO, 2021). These policy and conceptual developments underscore that environmental education in higher education should be evaluated in terms of learning outcomes related to competence, agency, and intended action, not only in terms of satisfaction with digital delivery.

Recent competence frameworks provide more concrete expectations for what such outcomes may entail. The GreenComp framework, for example, synthesizes sustainability competences into four interrelated domains (embodying sustainability values, embracing complexity in sustainability, envisioning sustainable futures, and acting for sustainability) and offers descriptors that can guide curriculum and assessment in formal education contexts (Bianchi et al., 2022). In sustainability research, Wiek et al. (2011) propose a complementary set of key competences (systems thinking, anticipatory, normative, strategic, and interpersonal competences), while Rieckmann (2012) highlights the importance of competencies such as critical thinking, problem solving, and collaboration for future-oriented higher education. Taken together, these sources suggest that environmental education objectives in higher education should explicitly address (a) conceptual understanding of coupled human-environment systems, (b) the ability to evaluate evidence and trade-offs, and (c) the capacity to plan and justify action in personal and civic contexts.

However, the empirical evaluation of e-learning for environmental education often remains fragmented. Many studies assess technology acceptance, usability, or general satisfaction, yet few link specific online learning design features to sustainability competence outcomes or to validated indicators of environmental attitudes and intended behaviors. In environmental psychology and education, the Revised New Ecological Paradigm (NEP) scale is widely used to operationalize pro-environmental worldview and to capture key dimensions of ecological belief systems (Dunlap et al., 2000). Such constructs are relevant because they are theoretically connected to pro-environmental intentions and behavior, and they provide a bridge between educational experiences and potential action. At the same time, a systematic review of environmental education outcomes for conservation indicates that well-designed

educational programs can influence knowledge, attitudes, and behaviors, but that effects vary with program design, context, and evaluation rigor (Ardoin et al., 2020).

Against this background, there is a clear need for integrated evaluation models that consider both the quality of e-learning implementation (e.g., clarity of instruction, interaction, assessment practices, and perceived support) and the environmental education outcomes that higher education seeks to foster (e.g., environmental literacy, sustainability competences, and intended actions). This gap is especially salient in the post-pandemic context, where universities are normalizing hybrid delivery and seeking evidence to guide institutional decision-making about digital learning. Without such integrated evaluation, it remains difficult to determine whether e-learning environments merely deliver content or whether they actually support the development of competence and agency required for environmental and sustainability challenges.

Accordingly, this study refines the environmental education objectives of the e-learning evaluation as follows:

- to examine students' perceptions of e-learning quality in environmental education courses (e.g., content organization, instructor presence and feedback, opportunities for interaction, and assessment clarity), and to interpret these perceptions in relation to established online-learning quality lenses (Garrison et al., 2000; Rapanta et al., 2020);
- to assess whether participation in e-learning is associated with changes in sustainability-oriented outcomes (e.g., environmental worldview and intended actions) using theoretically grounded constructs (Dunlap et al., 2000; Wiek et al., 2011);
- to identify design implications for higher education practice by aligning e-learning features with competence frameworks for sustainability and environmental education (Bianchi et al., 2022; Rieckmann, 2012; UNESCO, 2020).

By positioning the research gap at the intersection of e-learning quality and sustainability competence development, the study contributes to both higher education digital learning research and environmental education scholarship. Specifically, it aims to provide evidence that can inform course redesign and institutional quality assurance, while also clarifying how online learning environments can be structured to support values-driven, action-oriented environmental learning.

Method

Research Design

This study adopted a quantitative, non-experimental descriptive cross-sectional survey design to document students' experiences and perceptions of e-learning implementation in environmental education during the COVID-19 period. Descriptive survey designs are appropriate when the purpose is to systematically describe existing conditions, attitudes, and perceptions as they occur in a defined population, without manipulating variables or introducing interventions, thereby providing an empirical baseline for identifying implementation challenges and areas needing improvement (Creswell & Creswell, 2018; Fraenkel et al., 2019). Because the study sought to capture participants' views within a specific time window, the cross-sectional survey approach was used to produce a "snapshot" of experiences under pandemic-related remote learning conditions, while acknowledging that

such designs are primarily suited for description rather than causal inference (Fowler, 2014). In line with established survey methodology, the questionnaire format enabled standardized data collection at scale and supported the consistent measurement of perceptions, while attention to survey design principles aimed to minimize common sources of measurement and nonresponse error (Dillman et al., 2014).

Participants

The study population consisted of undergraduate students engaged in environmental education. A purposive sampling strategy was applied to ensure the participants had sufficient experience with digital learning platforms. The final sample included 224 students, comprising 121 females (54%) and 103 males (46%). These participants were drawn from semesters 1 to 5, representing three distinct academic cohorts. This multi-semester approach was intended to provide a broader perspective, comparing the adaptability of new students with those more experienced in the university's academic culture. Participation was entirely voluntary, and all respondents provided informed consent before completing the survey.

Data Collection and Tools

The research instrument was a structured questionnaire developed to evaluate the implementation of e-learning in university-level environmental education. The instrument comprised 10 items addressing: (1) learning media used; (2) file types most frequently shared; (3) perceived ease of online-based tests; (4) perceived independence in completing online-based tests; (5) honesty in completing online-based tests; (6) obstacles experienced during online-based tests; (7) continuity of using e-learning for environmental learning; (8) perceived need to further develop e-learning for environmental learning; (9) perceived importance of assessing environmental attitudes and behaviors; and (10) obstacles experienced in online learning. The tool underwent a rigorous content validation process involving a panel of experts in instructional technology and environmental science. Reliability testing yielded a Cronbach's alpha coefficient of 0.78, indicating good internal consistency. Data collected from the questionnaires were processed using descriptive statistics in Microsoft Excel to summarize item-level responses and describe the distribution of students' perceptions.

Findings

The findings indicate that the most frequently used medium/application for environmental learning was Google Meet (46.43%), whereas Google Classroom was the least used (11.61%). WhatsApp accounted for 25.00%. Detailed results are presented in Table 1.

Table 1

The Media Most Used in Environmental Learning

Answer	Total	Percentage (%)
Google Classroom	26	11.61
Google Meet	104	46.43
WhatsApp	56	25.00
Zoom	38	16.96
Total	224	100

Another finding shows that the most frequently shared file type was PowerPoint (56.25%), whereas images (JPEG) were rarely shared (0.89%). Other file types included PDF, video (MP4/MKV), and Word documents (DOC). For more details, see Table 2.

Table 2
Types of Files That are Often Shared

Answer	Total	Percentage (%)
Image	2	0.89
PDF	61	27.23
PowerPoint	126	56.25
Video	4	1.79
Word	31	13.84
Total	224	100.00

Table 3 demonstrates 53.57% of students agree that online-based tests are more manageable than offline ones. However, 13.39% of students disagree. They indeed have reasons for disagreeing and doubting. For more details, see Table 3.

Table 3
Opinions About Ease in Online-Based Tests

Answer	Total	Percentage (%)
Strongly agree	20	8.93
Agree	120	53.57
Doubtful	50	22.32
Disagree	30	13.39
Strongly disagree	4	1.79
Total	224	100.00

Based on the results, 53.13% of students agree that online-based tests will increase independence in learning. Meanwhile, other results show that 12.05% do not agree. Table 4 points out the total percentage of their opinions about student learning independence.

Table 4
Opinions About Online-Based Tests Independence

Answer	Total	Percentage (%)
Strongly agree	28	12.50
Agree	119	53.13
Doubtful	43	19.20
Disagree	27	12.05
Strongly disagree	7	3.13
Total	224	100

Based on the data presented in Table 5, participants' perceptions regarding academic integrity during online assessments varied significantly. A smaller proportion of students, accounting for 25.45%, expressed agreement regarding their honesty in answering online-based tests. Notably, the largest group of respondents (34.38%) remained neutral or undecided. These findings suggest a complex challenge in monitoring academic conduct

within a digital learning environment. A comprehensive breakdown of these responses, categorized by their respective levels of agreement, is provided in Table 5.

Table 5

Students' Opinions Regarding Honesty In Answering Online-Based Test Questions

Answer	Total	Percentage (%)
Strongly agree	10	4.46
Agree	57	25.45
Doubtful	77	34.38
Disagree	69	30.80
Strongly disagree	11	4.91
Total	224	100

Table 6 indicates that a substantial proportion of respondents perceived online-based tests as being affected by technical and logistical barriers (e.g., unstable connections, limited internet quota), which can disrupt the assessment process. More detailed item-level results are presented in Table 6.

Table 6

Opinions About Various Obstacles Occurring In Online-Based Tests

Answer	Total	Percentage (%)
Strongly agree	12	5.36
Agree	34	15.18
Doubtful	37	16.52
Disagree	101	45.09
Strongly disagree	40	17.86
Total	224	100

Regarding the continuity of online assessments beyond the emergency remote-teaching period, a majority of participants (55.80%) agreed that online-based tests should continue to be used in some form. This suggests that students view online assessment as a complementary option within hybrid or blended learning models.

Table 7

Opinions About the Continuity of Online Tests Implementation

Answer	Total	Percentage (%)
Strongly agree	31	13.84
Agree	125	55.80
Doubtful	34	15.18
Disagree	26	11.61
Strongly disagree	8	3.57
Total	224	100

Another result concerns the perceived need to develop a more systematic online learning evaluation model. Most students (54.91%) agreed with this need, suggesting that

evaluation frameworks should be usable both during disruptions and within routine hybrid implementations (see Table 8).

Table 8
Opinions About the Need to Develop an Online-Based Learning Evaluation Model

Answer	Total	Percentage (%)
Strongly agree	54	24.11
Agree	123	54.91
Doubtful	31	13.84
Disagree	12	5.36
Strongly disagree	4	1.79
Total	224	100

The respondents were also surveyed regarding their perceptions of the importance of measuring students' environmental attitudes and behaviors through digital platforms. A significant majority (64.29%) agreed that such measures should be integrated into online learning systems. These participants indicated that evaluating environmental attitudes and behaviors is essential for ensuring that theoretical concepts learned in the classroom are effectively translated into practical action (Table 9). It is important to note, however, that this study specifically captures student opinions on the necessity of these evaluations rather than directly measuring their ecological behavioral outcomes.

Table 9
Students' Opinions on the Importance of Assessing Environmental Attitudes And Behaviors

Answer	Total	Percentage (%)
Strongly agree	69	30.80
Agree	144	64.29
Doubtful	8	3.57
Disagree	3	1.34
Total	224	100

Based on the results, most students say that the frequent obstacle they experienced in learning is insufficient internet quota (53.13%). Meanwhile, the problem that is most rarely experienced is inadequate equipment. Some students complain about the Wi-Fi troubles quite a lot (29.91%). This is due to various conditions when students are in their respective homes. See Table 10.

Table 10
Obstacles Occurring In Online Learning

Answer	Total	Percentage (%)
Wi-Fi trouble	67	29.91
Insufficient quota	119	53.13
Inadequate equipment	38	16.96
Total	224	100.00

Overall, respondents reported generally positive perceptions of digital-based assessment in the environmental education course, particularly regarding accessibility. At the same time, concerns about academic integrity and technical constraints highlight the need for clearer assessment design, integrity safeguards, and learner support. Importantly, the findings are based on self-reported perceptions from a single institutional context and should not be interpreted as evidence of learning gains or changes in actual environmental behaviour.

Environmental education in higher education remains a critical priority, and digital modalities can support continuity and access when designed appropriately (El-Hmoudova & Milkova, 2015; Freed, 2018; Grosch et al., 2014; Khan & Masood, 2015). Future research should extend beyond perceptions to examine learning outcomes and, where relevant, validated measures of environmental attitudes, intentions, or behaviours within online and hybrid course designs.

From a practical perspective, institutions should anticipate barriers to remote assessment and learning (e.g., connectivity instability and limited internet quota) and provide targeted support such as low-bandwidth alternatives, improved access to campus Wi-Fi, or subsidized data packages for students with financial constraints (Alomyan, 2017; Hamouda & Tarlochan, 2015). Implementing such supports requires coordination among institutional units and relevant external partners.

Finally, participants' responses suggest that online assessment in environmental education should not be limited to traditional cognitive tests. Designing assessments that capture application, reflection, and action-oriented learning (e.g., projects, portfolios, or problem-based tasks) may better align with the aims of environmental education (Chouhan et al., 2017; Freed, 2018; Wang, 2017). Such approaches should be evaluated using appropriate validity evidence in future studies.

Conclusion

This study concludes that most university students reported a positive perception toward online-based assessments in environmental education. However, inadequate internet access remained the most frequently reported constraint that hindered optimal implementation of e-learning. Therefore, higher education institutions should prioritize reliable digital infrastructure and diversified assessment formats that remain accessible under varying bandwidth conditions. While this study provides a descriptive baseline for this context, the findings should not be generalized to other settings without further empirical testing. Future research should develop and validate integrated evaluation models that assess not only technical and pedagogical quality but also learning outcomes and, where relevant, students' environmental attitudes and intentions using validated measures.

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