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Learning Landscapes to Promote Environmental and Social Skills in Higher Education: A Proposal Aligned with SDG 11 (Sustainable Cities and Communities)

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Abstract

In the contexts of higher education and Education for Sustainable Development, universities face the challenge of preparing professionals capable of addressing complex urban issues related to Sustainable Development Goal 11 (SDG 11). Learning landscapes, grounded in the theory of Multiple Intelligences and Bloom's Taxonomy, have been proposed as a pedagogical framework to support the development of sustainability competencies and higher-order thinking; however, evidence regarding their applicability and viability in university teaching remains limited. This study examines an exploratory learning landscape–based training experience oriented toward SDG 11, focusing on university faculty perceptions. A design-based research approach with mixed-methods design was employed, emphasizing the co-construction, pilot implementation, and formative assessment of learning landscapes within a technical-scientific faculty development program. The results indicate generally positive faculty perceptions, particularly in terms of satisfaction, perceived learning, and professional development. Participants also reported pedagogical usefulness and perceived potential to enhance student motivation and engagement. However, stable curricular integration emerged as the main challenge, mainly due to design workload and the need for institutional support. Overall, the findings provide initial empirical evidence on the perceived value and limitations of learning landscapes in sustainability-oriented higher education and point to the need for further research and institutional conditions to support their implementation.

Keywords: learning landscapes; sustainable cities and communities; education for sustainable development; higher education; faculty development

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1. Introduction

In 2015, the United Nations adopted the 2030 Agenda and set out 17 Sustainable Development Goals (SDGs) as a roadmap to address major global problems [1]. Education is identified as a fundamental element for achieving these SDGs, as it is considered a cross-cutting axis for fostering citizens who are aware of global challenges and have a strong sense of social and environmental responsibility [2]. In 2017, Education for Sustainable Development was developed, defining the areas, methodologies, and resources for addressing the SDGs in schools and promoting the application of acquired knowledge in students' immediate environments. This framework also recognizes that, in a complex and dynamic world, a diversity of resources and methodologies is required to adapt to each student's characteristics [3]. This situation presents a significant challenge for teachers, as it requires a shift from traditional teaching approaches towards student-centered practices, with a greater emphasis on teamwork and the development of skills and competencies demanded by society.

In the sociological context in which these guidelines for Education for Sustainable Development were developed, reality was described as a VUCA world. This concept refers to an environment characterized by Volatility (constant change), Uncertainty (unpredictability), Complexity, and Ambiguity (distorted reality). In 2020, sociologist Jamais Cascio proposed a change in this sociological terminology, moving from the concept of a VUCA world to that of a BANI world: Brittle, Anxious, Non-Linear, and Incomprehensible [4]. This framework describes a fragile and volatile reality, with sudden impacts across technological, economic, and social domains. It also refers to an uncertain environment that generates anxiety due to insecurity about the present and the future. In addition, it retains the notion of complexity from the previous model and incorporates incomprehensible and ambiguous situations that affect society [2].

The acceleration of urbanization, together with the risks associated with climate change, biodiversity loss, and pollution, places cities at the center of the 2030 Agenda. SDG 11 addresses urban sustainability through objectives related to affordable housing, safe and accessible transportation, citizen participation in urban planning, heritage protection, the reduction in environmental impacts such as air pollution and waste management, and access to public and green spaces. In this scenario, Education for Sustainable Development is described as a cross-cutting approach linked to the development of skills, values, and attitudes associated with socio-ecological transformation and urban well-being [5]. The present study does not treat urban sustainability as an issue external to the educational focus, but rather as the curricular and applied framework within which the pedagogical proposal is designed and tested. SDG 11 provides a realistic context for structuring MI × Bloom pathways, aligning objectives, activities, and evidence with real campus- and city-level problems. For this reason, situating the work within the context of sustainability is essential for understanding the formative logic, the assessable products, and the study's purpose.

Education for Sustainable Development aims to provide students with theoretical and practical knowledge related to sustainability and the circular economy across disciplines [6]. However, training for sustainable development is complex due to its systemic nature and the involvement of multiple stakeholders [7]. In this context, active methodologies are proposed to support meaningful learning and student motivation in a changing society [8]. At the same time, companies increasingly demand professionals who can apply knowledge in real work contexts and who demonstrate soft skills such as teamwork, empathy, leadership, resilience, and adaptability to continuous change [9]. Responding to these demands requires universities to adopt pedagogical approaches that address diverse student abilities and different levels of cognitive engagement involved in learning and creation [10,11].

In higher education, this need is often associated with calls for transdisciplinary approaches and the development of sustainability-related skills through authentic learning experiences that connect academic curricula with professional contexts. These experiences are frequently articulated through projects focused on real urban issues. Within this framework, learning landscapes are presented as a pedagogical approach grounded in Gardner's Multiple Intelligences theory and Bloom's Taxonomy. This approach structures learning through the distribution of roles, the design of activities scaled to Bloom's levels, the activation of different intelligences, and the definition of evidence for student learning [12,13]. From the perspective of urban citizenship and culture, learning landscapes can also be interpreted as heritage and natural environments that support learning about sustainability, thereby fostering connections between the campus and the city in relation to SDG 11 and to discussions of heritage, community, and equity [14,15].

The objective of this study is to examine a training program grounded in learning landscapes informed by Multiple Intelligences and Bloom's Taxonomy, oriented toward SDG 11 in higher education. Specifically, the study focuses on: (a) the level of satisfaction among teaching staff, (b) perceptions of the applicability and pedagogical usefulness of the methodology, (c) motivation to design and implement learning landscapes autonomously, and (d) the perceived viability of its integration into teaching practice.

This article offers three complementary contributions to the recent international literature. (i) Theoretical/methodological: it makes explicit the alignment between personalization (Multiple Intelligences), cognitive progression (Bloom), and authentic assessment through an MI × Bloom matrix adapted to SDG 11 urban scenarios (mobility, air quality, waste, and public spaces), including roles, products/evidence, and rubrics that are transferable to science and engineering programmes. (ii) Design/implementation (DBR): it documents a co-construction and piloting cycle with university instructors, incorporating reusable artefacts (templates, analytic rubrics, and gamified narratives) and quality criteria (content validity and coherence among objectives, activities, and evidence), supported by triangulation of questionnaires, interviews, focus groups, and product-based evidence. (iii) Empirical and governance-related: it descriptively identifies the feasibility bottleneck (sustained curricular integration) and the enabling mechanisms (recognized time, activity banks, co-teaching, communities of practice, and institutional alignment with ESD/SDGs) as necessary conditions for long-term adoption in higher education. Although recent international studies address learning landscapes for sustainability and AI-supported educational experiences [16,17], they rarely examine the instructional design mechanisms, faculty development processes, and institutional feasibility conditions required to integrate SDG 11 systematically. Our study provides a transferable framework for design and implementation that addresses this gap and extends beyond the predominantly Spanish-speaking production [18].

This study examines the MI × Bloom framework as a viable instructional design tool within teacher development, rather than as a prescriptive curriculum model. The approach is based on specific design mechanisms—competencies, tasks, tests, and assessments—aligned with SDG 11 and current institutional agendas on sustainability.

2. Theoretical Framework

2.1. Learning Landscapes

The first practical uses of learning landscapes are linked to educational innovation experiences developed since the mid-2010s. These initiatives adopt the combination of Multiple Intelligences and Bloom's Taxonomy as a basis for instructional design and are systematized through institutional guidelines and faculty training materials [12,19–21]. The concept of learning sequences holds that the development of cognitive skills should be organized through learning experiences of increasing complexity, depending on the level of abstraction involved. This perspective converges with the literature on flexible itineraries and conceptual maps, which provides a methodological basis for visualizing non-linear learning paths and promoting learning autonomy, in line with the logic of learning landscapes [22].

Currently, learning landscapes are described as an instructional design tool that articulates Multiple Intelligences (MI) theory and Bloom's Taxonomy through a doubleentry matrix (MI × Bloom) [18]. Gardner's Theory of Multiple Intelligences (1983) [23] proposes that individuals possess multiple intelligences that operate in interconnected yet distinct ways. Gardner identifies eight types of intelligence: linguistic, logical-mathematical, spatial, musical, bodily–kinesthetic, interpersonal, intrapersonal, and naturalistic [23]. This approach challenges traditional unitary views of intelligence and emphasizes the diversity of learners' skills and abilities. From this standpoint, educational programming seeks to consider students' cognitive characteristics to adapt instructional design by emphasizing each type of intelligence in the learning process [24].

Bloom's Taxonomy provides a classification of learning objectives that supports educational planning by organizing objectives according to levels of cognitive complexity [25]. This taxonomy includes categories ranging from lower-order processes related to knowledge recall to higher-order processes involving analysis, synthesis, and evaluation [26]. In this sense, it serves as a reference framework for planning learning activities and defining objectives to support pedagogical progression aligned with increasing cognitive demand.

This study uses the MI × Bloom combination as an operational structure to guide initial design decisions, not as an exhaustive theoretical framework. The conceptual description is brief, outlining how the model informs teaching sequences for SDG 11 scenarios. This design focus aligns with the previous literature that reports the MI × Bloom approach's applicability in various educational contexts. The use of this approach has been reported in the Ibero-American context through journal articles, institutional repositories, and conference proceedings, with documented applications that can be transferred to higher education and faculty training settings [27,28].

2.1.1. Concept and Characteristics of Learning Landscapes

A learning landscape is defined as a programming framework that organizes assessable tasks and products using the Multiple Intelligences matrix and Bloom's Taxonomy. The Multiple Intelligences (linguistic, logical-mathematical, musical, bodily–kinesthetic, spatial, intrapersonal, interpersonal, and naturalistic) form the horizontal axis of the framework. This axis functions as a criterion for methodological variety and provides multiple entry points aligned with students' strengths and preferences [29].

The vertical axis corresponds to Bloom's levels: remembering, understanding, applying, analyzing, evaluating, and creating. This axis guides the alignment of objectives, activities, and evidence and helps avoid designs that focus exclusively on lower-order processes while supporting progression toward higher-order thinking and creative production [15,28,30] (Figure 1). The intersection of the two axes yields cells that specify operational verbs, expected products (e.g., thematic maps, technical reports, data panels, prototypes), and assessment rubrics. This design may be complemented by Information and Communication Technologies (ICT), resource curation, cooperative work, and, where appropriate, interaction with external actors [14,31].

The implementation cycle and characteristics of these learning landscapes can be described through three stages:

- ***Design***: At this stage, the topic is defined (e.g., urban sustainability, heritage, mobility), objectives and competencies are established, the Multiple Intelligences matrix and Bloom's taxonomy are used to plan tasks of increasing complexity and expected products. Analytical rubrics with performance criteria are also developed [21,32].
- ***Action***: This stage involves the integration of ICT and gamification elements (challenges, levels, badges), the organization of cooperative work with differentiated roles (analysts, designers, mediators, communicators), and the coordination of interactions with external agents such as municipal services, libraries, museums, or NGOs [12,33,34].

- *Evaluation*: Rubrics are used to assess knowledge, skills, values, and attitudes, and, where applicable, project-related impact. This process may be complemented by peer assessment and by the public sharing of results through forums, presentations, or exhibitions [15].

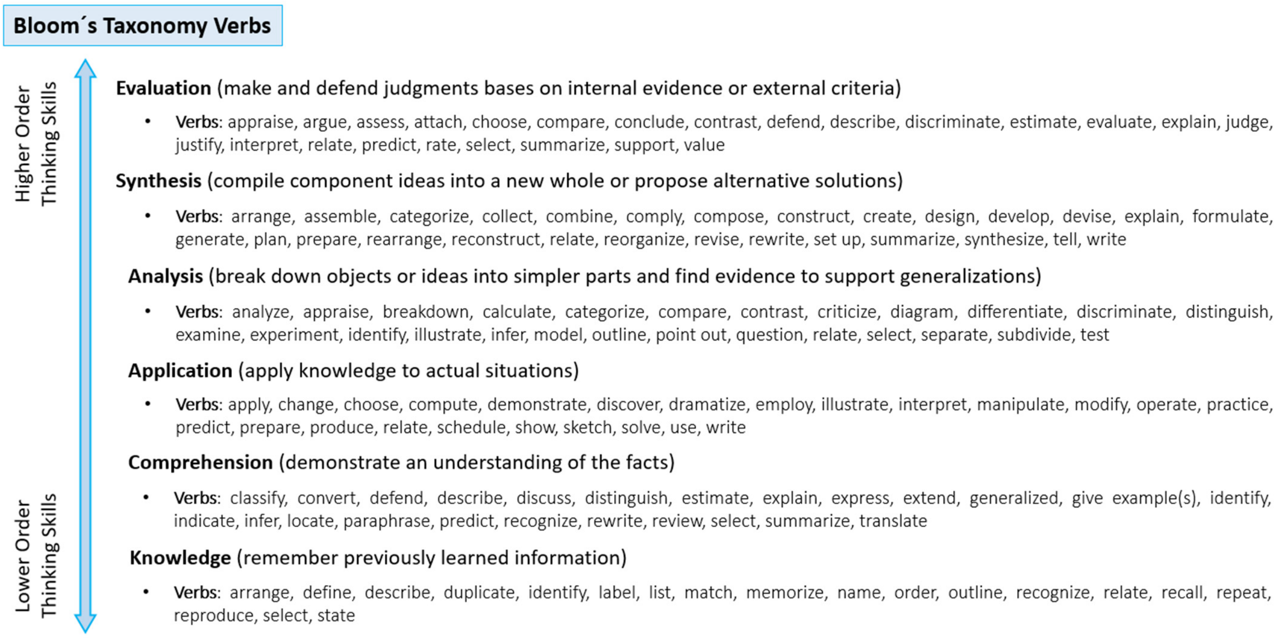

Figure 1. Bloom's Taxonomy Verbs.

In this process, the professor assumes the role of landscape designer. This role involves defining objectives, tasks, and evidence, developing content, and mediating interactions with external actors. The professor is also responsible for facilitating students' self-regulation and cooperation, as well as ensuring alignment among objectives, activities, and assessment through ongoing feedback processes [28,35].

The student, in turn, is described as taking an active role in the learning process. This includes selecting itineraries, managing progress, documenting evidence, participating in teams with complementary roles, and communicating results to real audiences [27]. This distribution of roles has been reported across disciplines, including the sciences, social studies, and languages, and its feasibility has been described in academic publications from Spain and Latin America [36].

The MI × Bloom approach has been applied in the literature through specific mechanisms that operationalize educational design: the use of programming templates, the allocation of differentiated roles within teams, the development of analytic rubrics, and the production of authentic evidence in real-world contexts. These elements support the alignment between objectives, activities, and assessment, which helps explain its capacity to foster motivation, self-regulation, and meaningful learning in university settings. Likewise, offering multiple entry points and scaled trajectories aligned with Bloom has been shown to contribute to broad and sustained participation [18,22].

2.1.2. Advantages and Disadvantages

The MI × Bloom matrix has been associated with approaches that seek to support personalized learning paths and attention to student diversity, often linked in the literature to principles of inclusive and quality education. Narrative elements and gamification have been reported to be associated with student motivation and self-regulation, with positive outcomes documented in quasi-experimental studies and case-based research [37]. Similarly, digital competence and cooperative work have been addressed in implementations of learning landscapes within Smart Learning Environments and hybrid settings [18]. In addition, Bloom's progression has been used as a framework to structure cognitive demand, often linked to the development of critical thinking and creativity in sustainability and citizenship-oriented contexts [28].

The academic literature in education and technology, including peer-reviewed studies and systematic reviews, reports outcomes such as increased motivation, autonomy, cooperation, and digital competence. These sources are used for illustrative and contextual purposes and do not constitute strong empirical evidence of effectiveness. The literature also identifies recurring challenges, particularly the need for faculty training and institutional support to reduce the time demands and design complexity that constitute major barriers in higher education [38]. Proposed strategies to address these challenges include developing templates, activity banks, teaching teams, and professional development programs [21,39].

A further risk concerns superficial playfulness: without rigorous alignment with Bloom's Taxonomy and assessment criteria, gamification may divert attention from learning objectives [40]. In addition, persistent gaps in access to ICT and educational resources have been noted. To address these constraints, the literature proposes multichannel designs, the combination of paper-based and digital formats, device lending, and tasks with low technological thresholds [27,41]. Finally, issues of assessment standardization and scalability are associated with the need for shared frameworks and the dissemination of good practices, including common rubrics, activity catalogs, and partnerships with local actors [34,42].

2.1.3. Critical Considerations and Rationale for the Approach

We acknowledge that Multiple Intelligences (MI) Theory is a subject of controversy in contemporary educational psychology, with heterogeneous empirical support and persistent difficulties in independently validating its constructs and measurements. For this reason, in this study, we employ MI as a design heuristic, not as an explanatory psychological model of stable traits. This critical and instrumental reading is aligned with recent syntheses that examine the implications and limitations of MI in higher education [43].

From an operational perspective, we combine MI with Bloom's Taxonomy to articulate pathways that incorporate diversified entry points and roles (MI) and a graded cognitive progression (Bloom) toward authentic products and analytic rubrics, consistent with experiential approaches to sustainability [17]. However, we note that Bloom can become reductionist if applied rigidly; its appropriate use requires alignment between objectives, activities, evidence, and operative verbs, avoiding prescriptive hierarchies [25].

Similarly, designs oriented toward ESD/SDGs risk turning into prescriptive checklists if they are not grounded in authentic evidence, shared quality criteria, and common frameworks for assessment and documentation. This underscores the importance of making templates, rubrics, and products explicit to ensure traceability and transferability [17,18].

Finally, MI $\times$ Bloom learning landscapes are not exclusionary: they can be integrated with, or replaced by, other active methodologies—PBL, TBL, case studies, service-learning, or studio-based environments—provided that design coherence and assessment transparency are maintained. Likewise, gamification resources should remain subordinate to learning objectives and rubric criteria to avoid superficial effects [44]. In line with this pragmatic position, we limit the interpretation of results to perceptions, descriptive feasibility, and the internal coherence of the design, reserving the incorporation of objective indicators and comparative or quasi-experimental designs for subsequent cycles.

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2.2. SDG 11: Curriculum, Located Scenarios, and Transdisciplinarity for the Development of Sustainability Competencies

SDG 11 (“Sustainable Cities and Communities”) provides a curricular reference for situating university learning in urban contexts, including mobility, air quality, waste management, inclusive public spaces, and heritage. Within this framework, Education for Sustainable Development (ESD) can be operationalized by defining learning objectives, employing active methodologies, and incorporating assessment strategies grounded in real contexts [5].

The recent literature on learning landscapes (MI × Bloom) in higher education describes their use as a design framework for organizing learning itineraries, structuring cognitive demand toward higher-order processes, and identifying evidence of student performance in real contexts [21,45]. This section brings together the curricular positioning of SDG 11 (2.5) and transdisciplinarity with the development of sustainability-related competencies (2.6), drawing on criteria and implementation mechanisms reported in recent studies and educational experiences [46].

From a curricular perspective, SDG 11 is translated into learning goals and tasks that the learning landscape organizes across Bloom’s Taxonomy levels and channels through Multiple Intelligences, supporting methodological variety and cognitive progression [22]. For example, sustainable mobility (target 11.2) can be addressed through sequences that include: (a) remembering/understanding regulatory frameworks; (b) applying capacity measurements and route mapping; (c) analyzing spatial-temporal patterns; (d) evaluating alternatives using equity criteria; and (e) creating prototypes or campaigns related to active mobility. Other targets, such as air quality and waste (11.6), inclusive public spaces (11.7), and heritage (11.4), follow similar designs, involving the production of maps, technical reports, dashboards, and policy briefs, as well as public dissemination to campus and city stakeholders [15,47]. This approach turns the campus and its surroundings into a “learning landscape”, understood as an expanded educational space that connects curriculum, territory, and citizenship, and is supported by institutional guides and repertoires [48].

To support alignment between objectives, activities, and evidence, MI × Bloom programming incorporates analytical rubrics structured around four dimensions: (1) knowledge (SDGs, regulations); (2) skills (data analysis, cartography, design, communication); (3) values and attitudes (responsibility, spatial justice, collaboration); and (4) impact (viability, participation, sustainability). These rubrics have been reported in Ibero-American educational contexts as tools for professor-student triangulation and peer assessment, and as resources that may facilitate transfer across disciplines [27,39]. In addition, narrative elements and gamification strategies (e.g., challenges, levels, badges) are described in the literature as supporting engagement and self-regulation when they are aligned with Bloom’s action verbs and rubric criteria [44,49].

Urban complexity is commonly addressed through transdisciplinarity approaches that integrate knowledge from fields such as engineering, environmental sciences, geography, economics, communication, education, and public management, together with the situated knowledge of local communities and actors, including municipal services, NGOs, companies, and neighborhood associations [50]. At an operational level, the MI × Bloom learning landscape defines differentiated roles, such as analysts (data, indicators), designers (prototypes, signage, cartography), mediators (participation, interviews), and communicators (campaigns, policy briefs), and allocates tasks across MIs to organize teamwork in configurations [31,51]. In the literature, this form of co-design has been associated with efforts to connect academic work with real contexts and to enhance the contextual relevance of student proposals [52].

In the university setting, sustainability competencies are commonly described as encompassing systemic, anticipatory, normative, strategic, interpersonal, and self-awareness dimensions. Their development is often associated in the literature with learning experiences that involve problem-solving, iteration, feedback, and reflection, rather than exclusively expository instruction [28,53]. Evidence from eco-design and construction has reported links between these competencies and the quality of decisions and project outcomes, particularly when learning itineraries include technical analysis, ethical deliberation, and the development of viable solutions [54]. Within MI × Bloom learning landscapes oriented toward SDG 11, these competencies are addressed through specific tasks, including trade-off analysis (e.g., emissions vs. accessibility), normative considerations related to spatial justice, strategies for participation and responsible communication, and reflection on the limitations and potential biases of available evidence [15].

The implementation of learning landscapes typically involves several elements: (a) MI × Bloom templates and activity banks; (b) faculty training programs focused on instructional design, authentic assessment, and ICT use; (c) communities of practice and co-teaching arrangements; and (d) forms of institutional governance that articulate ESD and SDG policies [21,39]. In terms of quality, the literature cites practices such as validating matrices and rubrics through expert judgment, pilot testing in small groups, assessing inter-rater reliability, and publishing resources in open-access formats to support transferability [55]. Common limitations, including time burden, the risk of superficial playfulness, gaps in ICT access, and scalability challenges, are discussed in relation to strategies such as alignment with Bloom and assessment criteria, multichannel design (paper/digital), collaboration with local actors, and public dissemination linking assessment and participation [18,20,56].

From a curricular perspective, learning landscapes function as an operational design mechanism that links learning outcomes, sequenced tasks, and analytical rubrics. This structure facilitates alignment with competency-based frameworks and supports the incorporation of sustainability-oriented learning experiences.

The use of SDG 11 in the university curriculum through MI × Bloom learning landscapes has been described as a way of connecting academic skills with forms of citizen agency through projects situated in urban contexts. In the literature, transdisciplinarity work and co-design with local actors are associated with efforts to enhance the contextual relevance of proposals, while rubrics are used to support the documentation and monitoring of learning processes. Evidence from Latin America describes the application of this approach across disciplines and educational levels, as well as its alignment with ESD and the 2030 Agenda, when accompanied by faculty training and institutional support [5,18].

Consequently, it is necessary to examine how university faculty perceive the applicability, pedagogical usefulness, and feasibility of learning landscapes oriented toward SDG 11. This gap provides the rationale for the study presented below.

3. Materials and Methods

The intervention is part of a mixed-method (qualitative–quantitative) design-based research (DBR) project aimed at the co-construction, piloting, and formative evaluation of learning landscapes aligned with SDG 11 targets (11.2, 11.4, 11.6, 11.7).

3.1. Scope of the Study

This study adopts an exploratory pilot design grounded in a Design-Based Research (DBR) approach. As such, it does not seek statistical generalization but instead aims to produce contextually grounded evidence to inform the iterative improvement of the instructional design and to examine its pedagogical feasibility in the target context.

This pilot orientation informs both the intentional sampling strategy and the analytical procedures employed.

3.2. Materials

The study utilized a set of research instruments and instructional artefacts: (a) a 14-item Likert-type questionnaire (1–10) measuring overall satisfaction, perceived usefulness, applicability to professional teaching practice, intention to use, motivation, and perceived feasibility of learning landscape integration; content validity was established through expert judgment and pilot testing, and internal consistency for the present sample was excellent (α = 0.95) [see Results, Table 1]; (b) an MI × Bloom programming matrix employed as an instructional design artefact to organize tasks along the dimensions of Multiple Intelligences (horizontal axis) and Bloom's Taxonomy (vertical axis), provided to participants as a co-design template (Table 2); (c) analytic rubrics comprising four dimensions (knowledge, skills, values/attitudes, and impact) to guide authentic and peer assessment; and (d) auxiliary training resources, including gamified narratives, procedural guides, and exemplars (maps, technical reports, data panels, prototypes, and policy briefs) used as referential supports during the session.

Table 1. Results derived from the professor satisfaction survey.

Item	Element to Be Assessed in the Survey	M	SD
1	The course has met my expectations	7.95	1.54
2	I feel better prepared to address diversity	7.75	1.74
3	Applicability of the content to my context	7.20	2.44
4	Intention to apply what has been learned	7.75	2.27
5	Usefulness of resources and examples	7.75	1.86
6	Improved knowledge of active methodologies	7.90	2.32
7	The dynamics of the course have helped my learning	8.55	1.23
8	Training contributes to my professional development	8.55	1.85
9	Learning landscapes as a helpful tool	8.25	1.94
10	Motivation for designing learning landscapes	7.70	2.00
11	Landscapes enable meaningful learning	8.60	1.93
12	They believe it will increase student motivation and participation	7.95	1.82
13	Feasibility of integrating landscapes into programming	6.40	2.35
14	Overall satisfaction with the training received	8.10	1.86

Table 2. MI × Bloom auxiliary matrix for working on Circular Economy and Sustainability content in the 2030 Agenda.

Bloom\Gardner	Linguistics	Logic–Mathematics	Spatial	Musical	Corporal–Kinesthetic	Interpersonal	Intrapersonal	Naturalist
Remember	Reading texts on the circular economy	Identify patterns in recycling systems	Observe infographics and concept maps	Listen to podcasts about sustainability	Identify recycling symbols on products	Discuss previous experiences with recycling	Written reflection on consumption habits	Exploring biodiversity and its relationship with recycling
Understand	Explain the circular economy in your own words	Solve fundamental problems about ecological footprints	Create outlines for sustainable processes	Relate sounds of nature to environmental impact	Demonstrate waste separation	Working in teams to understand environmental impacts	Write a diary about sustainable personal changes	Identify species affected by pollution
Apply	Write articles on sustainability	Analyze data on consumption and waste	Design educational posters	Compose a song about recycling	Building objects with reused materials	Participate in debates on environmental laws	Make a personal plan to reduce waste	Sorting waste in a real-world setting

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Table 2. *Cont.*

Bloom\Gardner	Linguistics	Logic–Mathematics	Spatial	Musical	Corporal–Kinesthetic	Interpersonal	Intrapersonal	Naturalist
Analyze	Compare linear and circular economic models	Interpreting statistics on climate change	Assess the environmental impact of different materials	Analyze rhythms in music inspired by nature	Experimenting with recycling techniques	Observe social dynamics in resource consumption	Reflecting on ecological ethical dilemmas	Examine urban ecosystems and their pollution
Evaluate	Arguing about environmental policies	Design surveys on consumer habits	Create visual models of sustainable economies	Evaluate the effectiveness of environmental jingles	Analyze the effectiveness of biodegradable products	Negotiating solutions to environmental problems	Self-assessment on sustainable habits	Diagnosing the environmental health of an area
Create	Write stories or essays about a sustainable future.	Propose innovative solutions to ecological problems	Design infographics and visual campaigns	Produce an eco-friendly musical theme	Building prototypes of eco-friendly products	Organize environmental campaigns in the community	Develop a personal sustainability manifesto	Designing an urban garden with native species

Note: Table 2 is an auxiliary operational matrix for co-design that organizes Bloom's verbs, products/evidence, and their connection to analytic rubrics, to align objectives–activities–assessment. It is not a psychometric scale, but rather an instructional scaffold designed to ensure methodological variety (Multiple Intelligences), cognitive progression (Bloom's Taxonomy), and the generation of assessable evidence during the pilot study.

3.3. Method

3.3.1. Design

The study adopted a mixed-methods Design-Based Research (DBR) approach (qualitative–quantitative), aimed at the co-construction, piloting, and formative evaluation of MI × Bloom learning landscapes aligned with Sustainable Development Goal (SDG) 11 targets (11.2, 11.4, 11.6, and 11.7). The DBR approach allows for iteration between: (a) context analysis; (b) construction of instructional artifacts (MI × Bloom matrices, rubrics, narratives, and guides); (c) classroom experimentation; and (d) reflection and adjustment, generating knowledge that can be transferred to university teaching practice [57]. The literature on learning landscapes in intelligent learning environments and educational technology supports the design's capacity to document improvements in motivation, autonomy, cooperation, and digital competence, while highlighting the need for faculty training and the value of the work conducted during the design phase.

To carry out this experiment, the students were divided into four groups, each dedicated to a different learning landscape itinerary (circular economy, sustainable energy, scientific method applied to environmental problems, food and sustainability). The practice was conducted in a university context, as part of the training process for university professors of technical subjects, with a highly diverse sample of professionals from various areas of scientific and technical knowledge. More specifically, the session aimed to train university professors on the benefits of designing and implementing MI × Bloom landscapes, in accordance with institutional guidelines and training materials.

3.3.2. Participants and Sampling

Twenty university instructors from technical and scientific fields participated in an institutional professional development activity. Participants ranged in age from 32 to 62 years, with teaching experience spanning 3 to 35 years. A purposeful sampling strategy was employed, consistent with DBR principles and the context of faculty professional development. The sample size and selection strategy were determined by feasibility criteria typical of pilot studies; consequently, these characteristics limit generalizability. Accordingly, the study prioritizes in-depth, context-sensitive understanding over statistical representativeness and is oriented toward situated understanding and design refinement, rather than population-level inference. The inclusion of instructors from diverse technical

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and scientific disciplines aligns with the transdisciplinary aims of the training programme and with the orientation of SDG 11.

3.3.3. Procedure

Within the DBR framework, the pilot followed a four-phase procedure integrating design, implementation, evidence collection, and iterative refinement. These phases were conducted following a brief theoretical introduction and participants' prior familiarity with the topic, which provided a common conceptual grounding for the experimental procedure:

- **Step 1—Analysis**: Identification of local problems and opportunities linked to SDG 11 (e.g., mobility flows, waste generation points, air quality, heritage, and public spaces), formulation of competencies to be worked on, and definition of evidence for verification.
- **Step 2—Design**: construction of MI × Bloom matrices (MI: horizontal axis; Bloom: vertical axis), drafting of analytical rubrics, and specification of gamification narratives and mechanics. For example, an auxiliary matrix was prepared (Table 2) and provided to professors to design landscapes aligned with SDG 11. The MI × Bloom matrix operates as the core mechanism of the instructional design: Multiple Intelligences enable task diversification and provide personalized entry points, while Bloom's Taxonomy structures a gradual cognitive progression from remembering to creating. This alignment systematically integrates learning objectives, activities, and evidence, and enables formative feedback through the use of analytic rubrics. This combination of personalization, cognitive progression, and authentic assessment has been associated in the literature with improvements in motivation, self-regulation, and meaningful learning, making it a coherent and well-justified approach for application in this SDG 11–oriented pilot study.
- **Step 3—Pilot implementation**: Deployment of activities according to Bloom's levels, with differentiated roles (analysts, designers, mediators, communicators), co-evaluation, and criteria-based feedback.
- **Step 4—Evaluation and adjustment**: product analysis, reflective journals, and questionnaire data; adjustment of matrices and rubrics, and documentation of lessons learned in the form of a classroom journal.

The following were used: (a) design artifacts (matrices, guides, narratives, rubrics); (b) student evidence (maps, reports, dashboards, prototypes, policy briefs); (c) rubrics (professor–student) for knowledge, skills, values/attitudes, and impact; (d) questionnaires on motivation and perceived usefulness; and (e) interviews/focus groups with professors.

3.3.4. Instruments and Data Collection

At the end of the session, a 14-item questionnaire with a 1–10 Likert scale was administered to assess overall satisfaction, perceived usefulness, applicability to teaching practice, intention to use, motivation, and the feasibility of integrating learning landscapes. Content validity was ensured through expert judgment and prior pilot testing, which included revisions of item wording, clarity, and alignment with the training objectives. Internal consistency was assessed using Cronbach's alpha; the corresponding coefficients are reported in the Results section. To mitigate common method bias, the questionnaire incorporated standardized instructions and anonymity, and its findings were triangulated with data from interviews, focus groups, and product-based evidence. Response consistency was reviewed as a basic attention check. Given the pilot nature of the study, interpretations remain descriptive and contextually grounded.

Given the exploratory nature of the study and the small sample size (N = 20), the questionnaire was used as a descriptive tool rather than as a latent measurement instrument.

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Advanced confirmatory techniques such as the Unmeasured Latent Method Construct (ULMC), confirmatory factor analysis, or AVE/CR estimation require substantially larger samples and stable latent structures, and were therefore not appropriate for this DBR pilot cycle.

To examine potential Common Method Bias (CMB), we applied both procedural and statistical remedies. Procedurally, anonymity, standardized instructions, and item clarity were ensured. Statistically, two post hoc diagnostics suitable for small-N exploratory designs were computed: (i) Harman's single-factor test, and (ii) full collinearity VIF.

3.3.5. Triangulation Strategy

Data integration followed a convergent approach, contrasting questionnaire patterns with qualitative categories derived from interviews and focus groups, as well as with product-based evidence (MI × Bloom matrices, rubrics, and prototypes). This process aimed to identify convergences, divergences, and complementary insights regarding feasibility, perceived usefulness, and design and implementation challenges.

Informed consent and anonymization of evidence were guaranteed at all times. Content validity was ensured through expert judgment and pilot studies; inter-rater reliability was monitored by double-checking product samples.

3.3.6. Data Analysis

Data analysis was restricted to descriptive statistics—medians and interquartile ranges (IQRs), as well as means and standard deviations—and to 95% confidence intervals for the questionnaire scores. Given the pilot nature of the study ($N = 20$), no hypothesis testing was conducted. The qualitative analysis combined thematic coding with mapping to the domains of the analytic rubric (knowledge, skills, values/attitudes, and impact). Results are reported with a descriptive emphasis, without causal claims, in accordance with the sample size and the exploratory pilot design.

4. Results

This section presents the results obtained by applying the methodology described for designing learning landscapes (MI × Bloom), as well as professors' perceptions of the feasibility of integrating these learning landscapes into SDG work in higher education. Given the pilot nature of the study and the sample size, results are presented using a descriptive, context-bound approach, without claims of causal inference. To enhance empirical precision, 95% confidence intervals (95% CIs) are reported for the key items.

4.1. Analysis by Professors to Work on SDG 11

Two questions were asked to assess participating professors' prior knowledge: "Are you familiar with the learning landscape methodology?" Do you think you need to improve your teaching practice to boost your students' motivation and learning? All course participants indicated that they were unfamiliar with the methodology, which is why they enrolled in the training. They also indicated that students are unmotivated by the way classes are conducted and that new methodologies and resources are needed to enhance motivation and learning. Likewise, they viewed the development of the activity positively in the context of the SDGs, particularly SDG 11, which is linked to university degrees in science.

The competencies that were proposed to be worked on are:

- The ability to assess environmental, social, and economic impacts in projects linked to SDG 11.

- The ability to design and implement circular economy and sustainability strategies in university and urban environments.
- The ability to understand interdependence between mobility, building, biodiversity, energy, and social cohesion.
- The ability to generate creative and viable solutions aimed at more sustainable cities and campuses.

Based on these competencies, each working group developed the different itineraries listed below.

4.2. Itineraries Designed by Professors to Work on SDG 11

These itineraries were developed during a joint working session with university faculty. The working groups were multidisciplinary, comprising professors from different disciplines who worked in teams of five.

4.2.1. Itinerary 1. From Waste to Resource: Circular Economy in Action (Goal 11.6)

This itinerary has the following overall objective: to transform waste into valuable resources by promoting the circular economy in the university community. To this end, the professors developed the following narrative to connect with the students:

"The university is a microcosm where waste—plastics, organic waste, paper, Waste Electrical and Electronic Equipment (WEEE)—is generated, with logistical, health, and environmental implications. This waste can be reintroduced as resources into production and consumption cycles, creating a virtuous circle that reduces environmental impact and improves campus sustainability".

This involves working on the following specific objectives:

- Identify and classify waste according to its use (quantities, transformation, reuse, reprocessing).
- Learn management mechanisms (logistics, technology, transformation) that facilitate treatment for reintroduction.
- Design and develop products suitable for reintroduction into the market, together with commercial strategies aimed at the university community.

And, to develop them, the following activities were designed according to Bloom's levels:

Remember: Reading of papers and regulations; construction of waste flow diagrams; initial discussion on typologies (IM: Linguistics, Mathematical Logic).

Understand*:* Concept map of value chains and risk matrix (critical points of generation and management) (IM: Spatial, Naturalist).

Apply: statistical analysis of consumption and waste; design of posters/infographics; construction of objects using recycled materials (compost bin, 3D filament) (MI: Logical-mathematical, Spatial, Bodily–kinesthetic, Intrapersonal).

Analyze: Explanatory video (Musical option); list of pros and cons for circulation alternatives (IM: Spatial, Musical, Kinesthetic-Bodily, Interpersonal, Naturalistic).

Evaluate*:* consumer habit surveys and life cycle analysis (LCA) of a priority flow (IM: Logical-Mathematical, Naturalistic).

Create: Circular product prototype and oral presentation with pitch to campus agents (IM: Linguistics, Kinesthetic Body Language, Interpersonal).

The following tools were proposed for evaluation: a four-dimensional rubric (knowledge, skills, values/attitudes, impact) and peer evaluation between groups; dissemination via a poster session and a policy brief.

4.2.2. Itinerary 2. Sustainable Energy for the Future (SDG 6; Interface with SDG 7)

This itinerary has the following general objective: to learn about renewable energy and its importance for urban sustainability; to explore hydrogen (H_2) as an energy vector. To this end, professors developed the following short narrative to connect with students:

"Energy is essential due to its environmental and social impact. Renewables offer alternatives to reduce emissions and improve energy justice. As an interdisciplinary environment, universities encourage critical thinking and teamwork to address this issue rigorously".

This involves working on the following specific objectives:

- Engage and motivate students through challenges and guiding questions.
- Analyze H_2 as an energy vector of the future produced from renewable energies and classify its types (green, blue, gray).

And, to develop them, the following activities were designed in the MI × Bloom matrix:

Remember*:* podcast on H_2 as an energy vector (IM: Musical); group discussion on energy consumption, environmental footprint, and uses of H_2 (IM: Interpersonal).

Understand: individual writing of conclusions and concept map of H_2 technologies (MI: Linguistic, Spatial).

Apply*:* experimentation with H_2 fuel cell (green/gray) in the laboratory (MI: Bodily–kinesthetic); video/infographic design about the experience (MI: Spatial); classification of H_2 according to sources (MI: Naturalistic).

Analyze*:* interpretation of energy data from a home (MI: Logical-mathematical) and writing of observations (MI: Linguistic).

Evaluate*:* short podcast (≈2 min) on individual energy responsibility (MI: Intrapersonal, Musical, Logical-mathematical).

Create*:* design of a prototype H_2 fuel cell from renewable sources (MI: Bodily–kinesthetic) and technical infographics of the prototype (MI: Spatial).

The following tools were proposed as evaluation methods: a rubric with criteria for experimental safety, data quality, communicative clarity, and technical viability; peer co-evaluation; and prototype presentation.

4.2.3. Itinerary 3. Science for a Sustainable Planet (SDG 6)

The professors who developed this itinerary set the following general objective: to apply the scientific method to analyze environmental problems and critically evaluate existing information. To this end, the professors developed the following short narrative to connect with the students:

"Environmental information proliferates in the media and informs political decisions with personal and collective effects. It is necessary to develop critical analysis skills and rigorously apply the scientific method to verify the accuracy of statements and distinguish evidence from opinion".

This involves working on the following specific objectives:

- Establish problems, hypotheses, objectives, and variables for analyzing environmental phenomena.
- Critically evaluate information (news, reports, policy briefs) on environmental issues.

And, to develop them, the following activities were designed in the MI × Bloom matrix:

Remember: guided reading of environmental articles/news items and visual outline of key concepts (MI: Linguistic, Spatial).

Understand: conceptual map of the phenomenon (e.g., urban smog) and classification of variables (sources, magnitudes, units) (MI: Spatial, Naturalistic).

Apply*:* protocol design (scientific method) and teamwork to collect data (e.g., PM/NO_2) with instruments or open data; logbook recording (MI: Spatial, Interpersonal, Naturalistic).

Analyze: hypothesis testing with basic statistics and interpretation of results (MI: Linguistic, Naturalistic).

Evaluate: structured debate on the quality of sources and biases; reflective journal on design decisions and limitations (MI: Interpersonal, Intrapersonal).

Create: short article (short communication format) or scientific poster and presentation in a public session (MI: Linguistic, Interpersonal, Naturalistic).

The following tools were proposed as evaluation methods: a Rubric with criteria for methodological rigor, data validity, analytical quality, and scientific communication; co-evaluation; and peer review.

4.2.4. Itinerary 4. Food and Sustainability (SDG 11.6; Interface with SDG 12)

Finally, the professors who developed this itinerary set the following general objective: to understand the environmental impacts of food production and consumption and to analyze decisions based on environmental, economic, and social criteria. To this end, the professors developed the following short narrative to connect with the students:

"The professional practice of engineering requires analyzing problems, generating alternatives, and making informed decisions. In food, these decisions must consider environmental impact, cost, and equity, in dialogue with regulations and value chains (producer–industry–distribution–consumption). This itinerary focuses on production and consumption from a sustainability perspective, articulating technical knowledge and participation".

With this, the aim was to work on the following specific objective:

- Apply the approach to a specific crop and area (e.g., peri-urban horticulture), integrating analysis of environmental footprint, productivity, and quality.

Consequently, the following activities were carried out in the MI × Bloom matrix:

Remember: reading scientific and technical texts on production and sustainability (MI: Linguistic); listening to podcasts/round tables/video blogs (MI: Musical); self-diagnosis of consumption habits (MI: Intrapersonal).

Understand: critical summary (MI: Linguistic); visual outline (MI: Spatial); debate between teams (MI: Interpersonal).

Apply: use of software to model cultivation (MI: Logical-mathematical); role play as farmer, producer, distributor, and consumer (MI: Interpersonal).

Analyze: conclusions from role play (MI: Interpersonal); interpretation of model results (MI: Logical-mathematical).

Evaluate: field visit (MI: Bodily–kinesthetic); interview with agents in the production chain (MI: Interpersonal) and naturalistic recording of the environment (MI: Naturalistic).

Create: technical proposal integrating model, map, and report (MI: Logical-mathematical, Spatial, Naturalistic) and summary document for decision-making (MI: Linguistic).

The following tools were proposed for evaluation: a rubric with criteria for technical quality, evidence integration, feasibility, and ethical/social considerations; and public presentation and stakeholder feedback.

4.3. Professors' Perception

In general terms, the design and implementation of the four MI × Bloom itineraries reflects that: (a) personalization and inclusion are embodied in flexible itineraries with differentiated roles; (b) narrative and gamification increase motivation and self-regulation when aligned with Bloom's verbs and rubrics; (c) the connection with SDG 11 promotes the authenticity of tasks and the public dissemination of results; (d) the teaching load in the design phase is reduced with templates, activity banks, and peer support.

At the end of the training session, an evaluation questionnaire was administered, consisting of 14 items scored on a Likert scale from 1 to 10, with higher values indicating greater agreement. The questionnaire assessed overall satisfaction, perceived usefulness, applicability in teaching practice, motivation to integrate learning landscapes, and perceived feasibility of implementation. Participation was 100% ($N = 20$), and the results indicate generally high ratings, reflecting a very positive reception of the course (Table 1). The analysis is limited to descriptive statistics and should be interpreted as perception-based evidence specific to the pilot's training context.

The descriptive questionnaire results ($N = 20$; 14 items, 1–10 scale) indicate high scores in course dynamics, professional development, and meaningful learning, whereas the feasibility of integration shows more moderate and heterogeneous values. Consistent with the pilot nature of the study, the interpretive focus is placed on distributions, 95% confidence intervals, and effect sizes, avoiding strong inferential conclusions. These patterns converge with qualitative evidence (interviews and focus groups) and with product-based evidence (matrices, rubrics, and prototypes), which reinforces the pedagogical usefulness of MI × Bloom learning landscapes and identifies sustained curricular integration as the primary challenge for their implementation. These results do not demonstrate impact; rather, they inform future design improvements.

The overall scale exhibited excellent internal consistency ($\alpha = 0.95$; 14 items; $N = 20$). Corrected item–total correlations ranged from 0.38 to 0.88; Item 6 showed the lowest value (0.38), while most items fell within moderate-to-high ranges. Cronbach's alpha if item deleted ranged from 0.95 to 0.96; removing Item 6 would marginally increase α. Therefore, a review of its wording is suggested for future cycles, while retaining it in the present pilot. This level of consistency should be interpreted with caution, as the data derive from self-reports collected at a single time point.

Given that the quantitative evidence is based on faculty self-reports collected at the same time and within the same training context, the results may be influenced by social desirability and common method bias. They may reflect positive expectancy effects regarding the intervention. Accordingly, interpretation remains strictly descriptive, without generalization beyond the pilot context.

Learning landscapes receive high ratings for their pedagogical potential, particularly in personalization and meaningful learning. These perceptions indicate that the methodology is relevant and helpful to participating professors. The evidence collected (questionnaire, interviews, and product-based data) did not reveal any explicit use of generative AI or LLMs by instructors during the pilot. This aspect is addressed in the Discussion because of its relevance to future design and evaluation cycles.

The questionnaire results confirm that the training has had a positive impact on the participating professors. The course was highly rated for usefulness and contribution to professional development, with high scores on items related to perceptions of learning and the quality of training dynamics. In particular, learning landscapes are valued as an effective tool for addressing diversity, enhancing participation, designing more flexible experiences, and promoting meaningful and personalized learning.

Post hoc CMB diagnostics showed patterns consistent with strong item homogeneity rather than method effects. Harman's single-factor test yielded a first component explaining 64.88% of the variance, a common result in unidimensional, highly correlated scales. Full collinearity VIF values were high (>10), which is expected in small samples with collinear perceptual items. Corrected item–total correlations ranged from 0.37 to 0.88, and the mean inter-item correlation was 0.61, indicating strong convergent tendencies and adequate item functioning for an exploratory pilot. These patterns should be interpreted as preliminary and will inform future refinement and validation.

Although curricular integration is perceived as the most significant challenge, professors' willingness to apply what they have learned, together with the high value placed on the methodology and resources, suggests strong potential for sustained implementation. Overall, the data provide solid empirical evidence of the relevance, acceptance, and impact of the training approach developed, supporting its continued use and scalability in university contexts focused on sustainability and teaching innovation.

5. Discussion

The training proposal shows clear potential to introduce active methodologies for skills development and to promote teacher motivation. The results indicate a highly positive perception of the MI × Bloom approach, particularly for items related to course dynamics, professional development, and meaningful learning (Items 7, 8, and 11). These findings are consistent with the literature, which indicates that learning landscapes are a practical approach to increasing teacher motivation, pedagogical confidence, and perceived usefulness, key elements for the sustained adoption of practices based on active methodologies [58]. These results coincide with empirical studies in ESD that also highlight teachers' high regard for active methodologies and experiential approaches, especially in terms of motivation and professional usefulness [16,17,53]. Likewise, other studies indicate that structured frameworks, such as itineraries and rubrics, facilitate perceptions of teaching feasibility [21,39]. The descriptive results reinforce the idea that the MI × Bloom approach functionally articulates the personalization of learning with balanced cognitive progression, consistent with the proposals of institutional guides such as CEDEC/INTEF and Escuela21, which argue that the MI × Bloom matrix guarantees flexible itineraries, methodological diversity, and authentic assessment without sacrificing conceptual depth [21,22].

In addition to reporting favorable perceptions, this pilot presents a design architecture for SDG 11. It includes MI × Bloom pathways, differentiated roles, authentic products, and analytic rubrics. It also provides reusable artefacts and criteria for institutional feasibility. This perspective is less developed in international contributions, which often focus on conceptual descriptions or isolated experiences and lack standardization in templates, assessment, and governance. Thus, our triangulated DBR approach complements and extends recent debates on learning landscapes for sustainability and AI-supported experiences [16,17]. These elements align with established principles of competency-based curriculum design in higher education and have been adopted in institutional training programs to improve teaching practice. We explain how to operationalize design mechanisms and organizational conditions to integrate SDG 11 systematically [18].

In line with the foregoing, the findings should be understood as perceptual evidence of acceptance and pedagogical usefulness within the context of the DBR pilot, with limited empirical weight for drawing causal or impact-related conclusions in the absence of additional objective indicators (e.g., externally assessed products, academic outcomes, or student participation data). The results presented are limited only to the perceptions of participating teachers. They do not allow us to infer effects on student learning, as this pilot study lacked direct indicators of academic performance and objective evidence of learning. Future research should include specific measures of learning outcomes—using both external rubrics and independently evaluated products—to more rigorously estimate the educational impact of learning landscapes in university contexts. Future studies should combine perceptual data with objective measures and expanded triangulation to mitigate potential biases and strengthen the validity of conclusions. We acknowledge that SDG 11 targets encompass heterogeneous domains, and that transferring the approach requires discipline-specific adaptation. Accordingly, we propose pathway-based specialization (e.g., mobility, air quality, waste management, heritage), tailored to the learning outcomes and professional knowledge of each degree programme, while maintaining the MI × Bloom logic (personalization and progression) and authentic products/rubrics as a shared core. This modular strategy enhances feasibility and professional relevance without compromising the framework's coherence.

The results of this DBR pilot program indicate high levels of acceptance and perceived usefulness of MI × Bloom learning environments; however, these findings should be interpreted cautiously. The feasibility of integration shows heterogeneity and moderate scores, pointing to structural barriers that go beyond pedagogical design:

(a) The design time and workload required to develop matrices, rubrics, and narratives.
(b) Curricular rigidity and pressure from the curriculum.
(c) Limited institutional recognition (protected time, incentives, and aligned teacher evaluation criteria).
(d) Unequal resources and pedagogical-technical support.
(e) Interdepartmental coordination is necessary to maintain cross-cutting experiences. These conditions help explain the gap between pedagogical acceptance and sustained implementation.

In addition, other alternative explanations for the positive ratings observed are plausible, such as the novelty effect of the methodology in a training context and the social desirability inherent in self-report measures. For this reason, the results are presented as descriptive and exploratory rather than as evidence of impact. In future cycles, the incorporation of objective indicators (e.g., externally evaluated product quality, rubrics with blind evaluators), student-level data (performance and engagement), and comparative or quasi-experimental designs will allow for a clearer distinction between perceptual effects and sustained effects on teaching practice and learning.

In line with the DBR approach, evidence from the pilot phase suggests that sustained adoption requires specific enabling mechanisms: reusable templates and activity banks; co-teaching and communities of practice; internal micro-credentials in instructional design and authentic assessment; and institutional governance that integrates SDGs/ESGs with recognized time for design and iteration. These elements not only reduce the initial workload but also standardize quality criteria and facilitate scalability.

Part of the literature on innovation in higher education warns that the sustained adoption of active methodologies depends less on their initial appeal than on organizational conditions (recognized time for design, reusable templates, communities of practice, co-teaching, technical support, and coherent institutional evaluation). In line with this evidence, the present pilot suggests that concrete enabling mechanisms—MI × Bloom templates and activity banks, internal micro-credentials in design and authentic assessment, and governance structures that align SDGs/ESD with protected time—are necessary to transform acceptance into curricular integration. In the absence of these conditions, feasibility is likely to remain the primary bottleneck.

The perceived positive impact on professional development supports the usefulness of training in active methodologies. Item 8, directly related to professional development, had a high mean (8.55), indicating that training consistently strengthened perceptions of teaching competence [59]. The literature suggests that the sustainable adoption of active methodologies depends on both the quality of the design and the teacher's confidence in implementing them, and the results of this study confirm this relationship in a university context oriented towards SDG 11 [18].

In terms of practical applicability, teachers perceive that the course content can be transferred to different teaching contexts. However, responses were heterogeneous with respect to immediate implementation. This perception is consistent with studies that highlight the versatility of landscapes in adapting to different disciplines [29,60], and their potential to integrate situated learning, narrative, gamification, and high-fidelity products [12,51]. Even so, the high rating of course resources and dynamics (Item 7; M = 8.55) suggests that the training adequately combined theory and practice, making it easier for teachers to visualize landscapes as concrete, practical tools. This point is particularly relevant, given that the literature has identified a lack of practical examples and reusable templates as a main barrier to adopting active methodologies [61].

The feasibility of integrating landscapes into teaching programs is the main challenge identified. This item (Item 13) has the lowest average (6.40), confirming that perceptions of implementation depend largely on structural factors such as design time, curriculum rigidity, and the availability of institutional support. This difficulty recurs in the literature on educational innovation and suggests that the approach's sustainability requires additional institutional strategies [18,62]. This gap appears repeatedly in studies of academic innovation and is often attributed to insufficient "conditions for adoption": lack of time for design, absence of institutional support, need for additional training, or scarcity of resources [28]. In our training, even when teachers perceive the methodology as valuable, there remains a sense that its full integration requires greater organizational support, as well as basic materials (prototype matrices, activity banks, reusable rubrics) that reduce the initial design burden.

Overall, the results indicate a favorable attitude toward the MI × Bloom methodology, as evidenced by high mean scores across items assessing satisfaction, motivation, and meaningful learning (Items 7, 8, 9, 11, and 12). However, integration feasibility (Item 13) received the lowest rating and exhibited the greatest heterogeneity, indicating that the main barrier identified is not in the model's acceptance, but in its implementation conditions [34,63,64]. This underscores the need for institutional support, basic materials, design time, and teaching networks to facilitate the structural integration of this into university programming. This type of support has proven crucial for sustaining active approaches, especially those that require a high degree of personalization and collaborative design [65].

In terms of pedagogical coherence, high scores on items related to meaningful learning and attention to diversity confirm that the training successfully conveyed the essence of landscapes: personalizing to include and activating to deepen. The literature highlights that landscapes not only diversify tasks but also provide a structured framework for developing cross-cutting skills—collaboration, critical thinking, reflection, communication, and creativity—all of which are essential in education for sustainability [66]. The positive perception of the teaching staff suggests that these elements were understood and valued, and that landscapes are interpreted as a tool aligned with the real challenges of contemporary education, particularly those related to SDG 11.

Although generative AI tools and large language models (LLMs) were not used in this pilot project, we recognize their potential for instructional design, feedback processes, and evidence production. For this reason, we propose their gradual, controlled integration into subsequent design cycles, ensuring adherence to criteria for responsible use, traceability, and consistency with the MI × Bloom model structure.

Overall, the main facilitating factors identified are the use of templates, reusable examples, and teacher co-design, while the most significant barriers are related to the design workload, lack of recognized time, and curricular rigidity, in line with previous studies [18,34,62].

Finally, it is clear that learning landscapes—especially those framed within SDG 11 and grounded in real urban narratives and issues—are a relevant, motivating methodology with high transformative potential for university teaching practice. The results not only validate

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the intervention but also align with a growing body of academic evidence recognizing its value in higher education contexts.

In summary, this study is positioned as an exploratory DBR pilot project that prioritizes design transparency over impact claims. We explicitly delimit interpretations to descriptive evidence, report on viable CMB diagnostics and item-level functioning with the available N, and document concrete curricular mechanisms (competency alignment, MI × Bloom pathways, analytical rubrics, and authentic products). Within this scope, the manuscript offers a transferable design architecture and clearly identifies the conditions necessary for its practical adoption, while outlining a realistic agenda for its subsequent validation and expansion.

6. Conclusions and Implications

This pilot study provides perceptual evidence regarding the acceptance and usefulness of the MI × Bloom approach in teacher education oriented toward SDG 11. It does not seek to demonstrate impact, but rather to offer indicative insights to inform design improvements. Given the sample size, the reliance on self-reported data, and the absence of a comparison group, the results should be understood solely as contextual evidence and not as generalizable findings.

Within these limitations, the main takeaway is that participants perceived MI × Bloom as useful for addressing learner diversity and for designing personalized learning activities. These perceptions, together with the operational elements developed (matrices, roles, rubrics, and authentic products), provide a foundation for the next design iteration, without constituting evidence of causal effects.

However, the stable integration of learning landscapes into programming instruction was identified as the primary challenge. This limitation aligns with the obstacles reported in the literature—namely, the design burden, the technical complexity of certain tasks, and the need for time and institutional support. Therefore, if this methodology is to be implemented, universities must adopt models of support, shared and collaborative materials, communities of practice, and professional development policies that facilitate sustained implementation. These aspects should be considered necessary enabling conditions for evaluating in future iterations for its sustained transfer.

To strengthen external validation beyond the perceptual evidence obtained in the pilot, subsequent iterations will align student products and rubrics with established SDG 11 indicator sets for university campuses (e.g., sustainable mobility, air quality, waste management, and use of public spaces/green areas). This alignment will enable triangulation with external metrics and the development of comparable reports across cohorts, while maintaining the coherence of the MI × Bloom approach. Consequently, this pilot project should be evaluated in terms of its transparency and contribution to instructional design, rather than in terms of causal or generalizable claims. Its value lies in providing a clearly specified and reusable architecture for SDG 11-oriented teaching, which can be replicated and tested independently. Confirmatory validation, external criteria, and comparative designs will be addressed in the future, as the necessary conditions are met.

Implications. In terms of pedagogical promise, the results suggest that MI × Bloom learning landscapes may foster personalization and meaningful learning; however, their sustained implementation requires enabling conditions such as recognized design time, reusable templates and activity banks, co-teaching, communities of practice, pedagogical–technical support, and institutional alignment with the SDGs/ESD. From an empirical evidence perspective, expanded triangulation incorporating objective indicators and student-level data, as well as comparative or quasi-experimental designs, is needed to estimate effects beyond perception and to assess transfer to learning outcomes and established teaching practices. Subsequent iterations should therefore include comparative or quasi-experimental designs, longitudinal measures, and objective indicators to examine mechanisms and estimate effects beyond perceptual evidence.

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