Ella Hamonic · Rémi Sharrock (Eds.)

# Digital Education: Shaping Sustainable Lifelong Learning for All in the Era of AI

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Editors

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# Preface

It is our pleasure to present the proceedings of the European MOOCs Stakeholders Summit 2025 (EMOOCS 2025), held at Télécom Paris in Palaiseau from June 30th to July 2nd, 2025. As volume editors and Program Committee Chairs, we are delighted to offer an overview of this year's scientific program, which reflects the ongoing transformation and critical challenges in online education—particularly in the context of artificial intelligence (AI) and sustainable lifelong learning.

The central question addressed by EMOOCS 2025 was: How can we shape sustainable lifelong learning for all in the era of AI?

Fifteen years ago, Massive Open Online Courses (MOOCs) captured global attention by promising high-quality, open-access education at scale, expanding lifelong learning opportunities for millions. This year's theme was both timely and significant, as education systems worldwide are navigating complex transitions fueled by rapid technological innovation. While initial hopes were high, the landscape has since shifted: many MOOC platforms have evolved into broad online learning providers, sometimes moving away from their foundational mission of openness.

Today, the integration of AI into educational practices promises a new era of transformation. AI is already influencing teaching and learning methods, offering personalized and adaptive educational experiences that could redefine knowledge acquisition, skills recognition, and professional development. However, as with the early MOOC movement, widespread adoption of AI challenges us to consider not just innovation for its own sake, but innovation that is responsible, inclusive, equitable, and sustainable.

The future of online learning now depends on how diverse stakeholders—universities, public authorities, micro-credentialing providers, labor market organizations, social partners, and learners—work together within a collaborative ecosystem. This ecosystem must foster both technological innovation and systemic change, aligning with emerging labor market needs and evolving educational and credit recognition models. Special attention is warranted for micro-credentials, which have the potential to democratize access to recognized learning outcomes and support learners at all stages of life and career.

Moreover, technological advances carry significant financial, technical, and environmental considerations. Large language models and AI tools necessitate responsible stewardship to avoid exacerbating existing digital divides. International frameworks, such as the UNESCO AI competency guidelines and the European Council Recommendation on Micro-credentials (2022), provide calls to action for fair and ethical integration, emphasizing human-centered and sustainable principles.

Sustainability—environmental, economic, and social—remains a cornerstone of this discussion. As life-long learning opportunities expand, questions persist regarding access, scalability, and the responsible deployment of new technologies. EMOOCS

2025 therefore sought to unite a vibrant international community of researchers, practitioners, policymakers, and innovators to address these questions, share best practices, and highlight cross-sectoral perspectives among stakeholders from Europe and beyond.

This year's conference consisted of a rich program comprising Research and Experience tracks, which are represented in these proceedings. Additional conference tracks (World and Business Policy), as well as practical workshops and demonstrations, further broadened the perspectives—though they are not included in this volume.

EMOOCS 2025 attracted 79 paper submissions across the Research and Experience tracks. Each submission underwent a rigorous double blind peer review process, receiving at least two independent reviews by program committee members or external reviewers with appropriate expertise. After thorough deliberation, 20 papers were accepted for publication in these proceedings: 12 full research papers and 8 experience papers, reflecting an acceptance rate of approximately 25%. The accepted contributions exemplify state-of-the-art research, practical approaches, empirical studies, and novel insights into the sustainable integration of AI, MOOCs, and micro-credentials for lifelong learning.

Invited papers do not form part of these Springer proceedings. For any papers co-authored by members of the program committee, strict measures were taken to ensure impartiality; such submissions were assigned to independent reviewers, with the concerned committee members excluded from any involvement in their review and selection.

The success of EMOOCS 2025 rests upon the dedication, commitment, and collaborative spirit of the international community. We gratefully acknowledge the efforts of the Program Committee, the reviewers, the Organizing Committee, the student volunteers, and the keynote speakers, whose expertise and judgment ensured a high scientific standard and a lively discussion across all conference contributions.

We would also like to thank our sponsors and institutional partners for their invaluable support and engagement. Their contributions underpinned the realization of this event and the future of open, sustainable online learning for all.

We sincerely hope that this volume will inspire further research, discussion, and innovation in online education. May it serve as a resource and reference for those working to create sustainable, equitable, and human-centered approaches to lifelong learning in the era of AI.

June 2025

Ella Hamonic
Rémi Sharrock

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# Raising Awareness on Sustainability Through Digital Learning: An Institutional SPOC for All Newly Admitted Students, Moving Towards a MOOC Perspective

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**Abstract.** The University of Liège (ULiège) has developed a Small Private Online Course (SPOC) on sustainability and transition, designed for new students. This initiative aims to raise awareness of environmental and societal challenges while offering students learning flexibility through an online format. The study reveals a high engagement rate (84%) and a strong success rate (86% to 94%), although involvement varies depending on student profiles: some prefer written materials or a selective approach to content.

Overall, students perceive the course as beneficial: 80% believe they have acquired new knowledge, and 83.2% find the online format suitable. However, tests are sometimes seen as a formality rather than a true learning tool. The study suggests enhancing the interactivity of assessments, adapting video formats, and promoting supplementary resources to enrich the learning experience.

ULiège is considering expanding the program's impact by transforming it into a Massive Open Online Course (MOOC), making it accessible to a broader audience, particularly within continuing education. This development aligns with a broader strategy to integrate Education for Sustainable Development (ESD) into higher education. The SPOC analysis highlights both opportunities and challenges associated with digital learning, emphasizing the importance of an interdisciplinary approach and continuous adaptation to students' needs to maximize the program's educational impact.

**Keywords:** Sustainability Education · Digital Learning Innovation · Higher Education Transition

## 1 Introduction

In response to major environmental and societal challenges, the University of Liège (ULiège) has placed sustainability and transition at the core of its strategic plan, aiming to prepare new generations for a more resilient and responsible world. This commitment underscores the growing need for enhanced education in sustainability. Studying the effectiveness of such education is therefore increasingly important [1].


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Academics must continuously explore how sustainability can be integrated into higher education institutions (HEIs) [2–4], as sustainable development is now recognized as HEI's fourth mission [5, 6]. This calls for the integration of sustainability at all levels and the adoption of inter- and transdisciplinary approaches [7, 8].

ULiège has developed a Small Private Online Course (SPOC) on sustainability and transition for all new students, with the goal of progressively evolving it into a MOOC accessible to a wider audience.

Based on Hueske *et al.* [9], this study examines the impact of the "Sustainability and Transition" SPOC through the concepts of *formalis* and *materialis*, while also exploring perception and participation. *Formalis* refers to organization and teaching methodology; *materialis* highlights the importance of concrete content. Perception concerns students' felt impact, and participation emphasizes the role of active engagement in learning.

### 1.1 Formalis (Mode of Delivery)

In this context, ULiège is transforming its educational practices by integrating Education for Sustainable Development (ESD) transversally into the curriculum for new students, through a structured 2-credit (ECTS) system. This approach aims to operationalize ESD principles by combining interdisciplinary training with disciplinary anchoring, in line with international recommendations on sustainability integration in higher education [10, 11].

This commitment is reflected on one hand in a mandatory interfaculty SPOC awarding the first ECTS, and on the other hand, in a second ECTS organized within each faculty, enabling disciplinary contextualization of sustainability issues. This dual approach combines global awareness of major environmental and societal challenges [12] with contextualized application in specific areas of expertise [13].

As an asynchronous digital training program, the "Sustainability and Transition" SPOC supports an innovative pedagogical model ensuring flexibility and accessibility, in line with Open and Distance Learning (ODL) principles applied to ESD [14]. Its instructional design follows a structured pathway, alternating educational video capsules and formative multiple-choice assessments, to enhance cognitive engagement and knowledge retention [15].

By involving experts from ULiège and civil society, this initiative adopts an interdisciplinary approach essential for a systemic understanding of sustainability challenges [16]. All content is structured into 54 video capsules on the institutional eCampus platform, ensuring effective knowledge transfer and compliance e-learning quality standards in higher education [17].

While literature highlights the potential of e-learning for sustainability education - especially in lifelong learning and adult education [14] - research on the integration of digital tools for ESD in higher education remains limited [18]. This gap underscores the need to explore how digital environments can foster student awareness and ownership of sustainability challenges [10].

The SPOC project offers a chance to empirically evaluate digital learning's impact on sustainability competencies. It is part of constructivist and socio-cognitive approach [19]. Its asynchronous, multimodal structure connects theoretical knowledge

with interdisciplinary applications, supporting students' systemic understanding of socio-environmental challenges [11].

### 1.2 Materialis (Content)

The online course "Sustainability and Transition" is a mandatory course accessible to new students via the institutional eCampus platform. The structured, progressive, and conditional learning path allows students to progess step by step, completing assessments in a set sequence. The estimated workload is 12 h, comprising 54 expert-led video lectures from a multidisciplinary perspective. These lectures, spanning economics, law, philosophy, architecture, medicine, science, and sociology, total about 10 h, supplemented by 2 h of automatically graded assessments.

The course includes 29 assessments, each with three multiple-choice or multiple-response questions, auto-corrected. These are randomly drawn from expert-provided question banks (5 to 10 items per expert). To pass (60%), students have unlimited attempts.

The course is structured into four sequential modules aligned with multiple Sustainable Development Goals (SDGs), ensuring a holistic and accessible approach across disciplines.

**Introductory Module: Eco-Anxiety.** This module explores the psychological effects of environmental and societal crises, emphasizing resilience and proactive engagement. It supports SDG 3, "Good Health and Well-being," by addressing mental health and promoting strategies for individual and collective resilience.

**Module 1: Environmental and Social Challenges.** This module provides foundational knowledge of planetary boundaries and societal needs, highlighting contemporary challenges through a cross-cutting lens tied to SDGs 3-10 and 13-16 (Table 1).

**Module 2: Systemic Analysis of Root Causes.** Fostering holistic thinking, this module examines links between environmental and social crises. A systemic analysis of food systems illustrates impacts on ecosystems, food security, and consumption, aligning with SDGs 2, 9, 11, 12, 15, and 16.

**Module 3: Responses and Action Levers.** Adopting a forward-looking perspective, this module introduces sustainability and transition strategies. It presents actionable solutions at individual, collective, and institutional levels, emphasizing innovation, policy, and collaboration. It aligns with SDGs 8, 9, 11, 16, and 17 (Table 1).

### 1.3 Participation and Performance (Engagement and Involvement)

The first session of the course ran from September 16 to December 17, 2024. Participation and performance data were extracted from the institution's official learning management system, Blackboard Learn. For each course, the platform records the total time spent by each student, as displayed in the "Course Activity" section under the "Analytics" tab. However, this metric tends to be overestimated, as time continues to accumulate even when a student opens the course but remains inactive or leaves it running in the

**Table 1.** SDG Alignment by Learning Module

| SGD\Modules | Introductory module | Module 1 | Module 2 | Module 3 |
|---|---|---|---|---|
| SGD 2 - Zero Hunger | | | V | |
| SDG 3 - Good Health and Well-being | V | V | | |
| SDG 5 - Gender Equality | | V | | |
| SDG 6 - Clean Water and Sanitation | | V | | |
| SDG 7 - Affordable and Clean Energy | | V | | |
| SDG 8 - Decent Work and Economic Growth | | V | | V |
| SDG 9 - Industry, Innovation, and Infrastructure | | V | V | V |
| SDG 10 - Reduced Inequalities | | V | | |
| SDG 11 - Sustainable Cities and Communities | | | V | V |
| SDG 12 - Responsible Consumption and Production | | | V | |
| SDG 13 - Climate Action | | V | | |
| SDG 14 - Life Below Water | | V | | |
| SDG 15 - Life on Land | | V | V | |
| SDG 16 - Peace, Justice, and Strong Institutions | | V | V | V |
| SDG 17 - Partnerships for the Goals | | | | V |

background. The analyzed cohort includes 2,551 newly enrolled students from six faculties at ULiège: Science (4.3%), Medicine (30%), HEC (34%), Philosophy and Letters (1%), Law (30%), and Applied Sciences (0.3%). Thus, not all faculties or programs were represented in the study.

The course completion rate was 84%, with 2,139 students completing the entire learning path and passing all assessments with at least 60%.

In every faculty, average scores exceeded 60%, with success rates of 93.44% (Applied Sciences), 91% (Law), 92% (Medicine), 86% (HEC), and 94% for both Science and Philosophy and Letters. These results are noteworthy, considering students attempted each test only twice on average.

Time spent on the course is shown below (Table 2).

Over 35% of students spent under six hours, while 40% invested more than ten.

This suggests that nearly 60% did not watch all videos yet still passed. Full viewing was not required; simply opening a module and watching a few seconds allowed

**Table 2.** Time spent on the course

| Time Spent on the Course | Percentage of Students |
|---|---|
| Less than 4 h | 21% |
| Between 4 and 6 h | 14,63% |
| Between 6 and 8 h | 13,04% |
| Between 8 and 10 h | 10,47% |
| Between 10 and 12 h | 9% |
| More than 12 h | 31% |

progression. Transcripts were also available in downloadable PDF format. Conversely, 40% spent enough time to likely view all videos in full.

These findings reflect strong participation and engagement. The positive outcome is further supported by student perception data, discussed in the next section.

### 1.4 Perception (Student Reactions)

To analyze student perceptions, we administered a 37-question survey at the end of the online course. It explored motivation, satisfaction, communication, and student's sense of competence and control. Our analysis focused mainly on perceptions of course format and content.

**Engagement and Time Spent**

The course's structured, progressive format was generally well received, with 60% stating it improved engagement.

Video content engagement was relatively high: 35.2% reported watching at least half of the modules, and 38.2% said they watched all (Fig. 1A). Comparing self-reported data with platform stats—and given that all videos total about 10 h—we can infer that the 32.5% of students who spent 6–12 h watched at least half, while the 31% who spent over 12 h likely viewed them all.

Meanwhile, 22.5% reported watching less than half, aligning with eCampus data showing 21% spent under four hours.

Exploration of extra resources was moderate: 62.2% consulted, less than half or none. This may reflect the fact that core content alone was sufficient to pass assessments, reducing the need for supplementary materials.

**Perception of Progression and Assessments**

The course's sequential structure appears to have shaped students' perception of difficulty. While assessments were central to the learning path, opinions were mixed: 41.5% rated them as moderately satisfactory, and 38% evaluated them positively (Fig. 1B).

Given the high success rates with minimal attempts (as noted earlier), this contrast may indicate that assessments were viewed more as a hurdle than as an engaging learning tool.

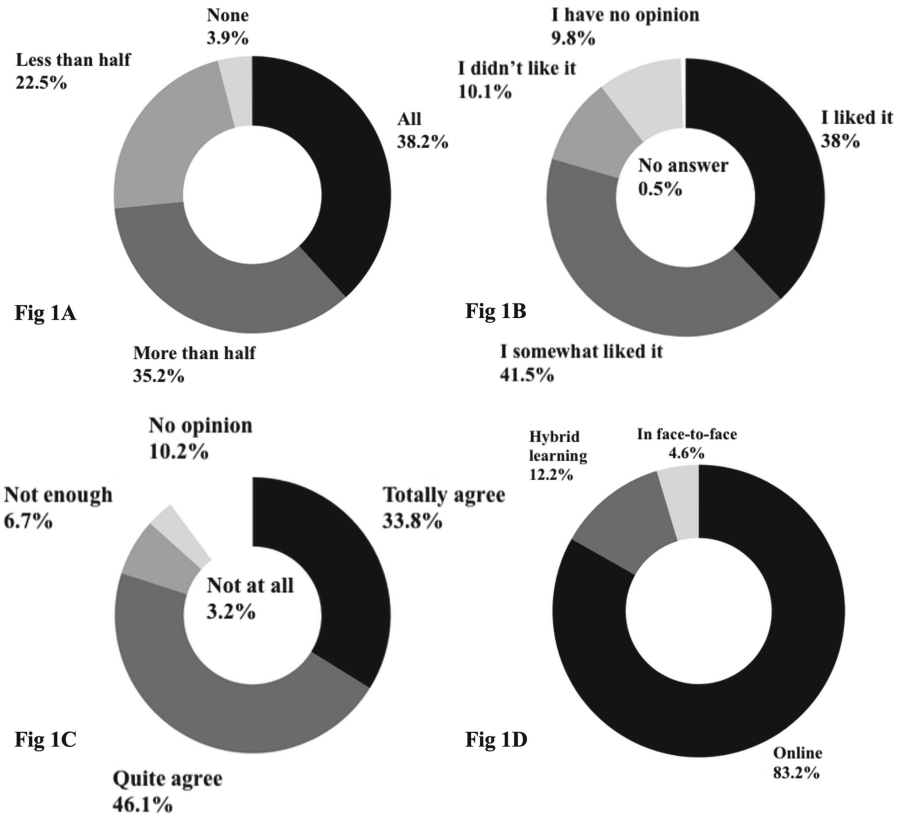


**Fig. 1.** Students' perception data. Figure 1A: engagement and time spent. Figure 1B: perception of progression and assessments. Figure 1C: impact on learning and satisfaction. Figure 1D: format and accessibility.

The effort required was generally seen as moderate to easy: on a scale from 1 (very difficult) to 5 (very easy), over 88% rated the course at least a 3, showing it was manageable. This perception aligns with the high 84% completion and success rate.

Survey responses also gave insight into how students viewed the course content: 86% found the materials (videos, transcripts, resources) appropriate and comprehensive, 12% were neutral, and just 2% expressed dissatisfaction.

**Impact on Learning and Satisfaction**

Despite being mandatory, students generally perceived the course's educational value positively: nearly 80% reported acquiring new knowledge (Fig. 1C). Over 72% felt that the assessment level matched the content, while just under 19% found it too easy. Combined with high success rates, these findings suggest the course met learning objectives with appropriate rigor, without hindering student success.

Satisfaction with the topics covered was also strong, with 75.2% expressing approval. Fewer than 10% wanted additional topics.

**Format and Accessibility**
From a technical standpoint, 72.9% of students were satisfied with the platform's usability and navigation. The alternation of video modules and assessments was perceived as an effective strategy.

The online format was particularly well received: 83.2% considered it the most suitable, compared to 12.2% who preferred a hybrid format and 4.6% who favored in-person instruction (Fig. 1D). This fully online approach proved motivating and satisfying for many students.

## 2 Discussion, Benefits, and Perspectives

### 2.1 Participation and Engagement

The analysis of participation data highlights a strong student engagement, with a completion rate of 84%. This is notable given the heterogeneity of student profiles across six faculties. However, the limited representation of some faculties (e.g., Applied Sciences at 0.3% and Philosophy and Letters at 1%) limits the generalizability of these results.

Time investment varied, reflecting diverse strategies. While 40% of students spent over 10 h on the course, more than 35% spent fewer than 6. This suggests that some adopted a selective approach, focusing on assessment-related content or using written materials (PDF scripts) instead of videos. The fully online format's flexibility enabled students to adapt their learning to individual needs and constraints.

### 2.2 Performance and Success

The consistently high success rate -averaging above 86% and peaking at 94% in Science and Philosophy and Letters- attests to the pathway effectiveness. The average of two attempts per test suggests that assessments were accessible and well-calibrated. However, this raises a key question: did they truly assess learning, or were they seen as a formality? The course's mandatory nature may have significantly influenced success, regardless of deep engagement.

Success likely stems from both institutional enforcement and thoughtful pedagogical design. The fully online format offered flexibility, while expert-led video modules added a professional and engaging dimension, enhancing student commitment.

### 2.3 Student Perception

Self-reported data confirm this positive perception: 80% of students felt they had acquired new knowledge, and 72.3% found the tests to be appropriately aligned with the course content. However, opinions on assessments were mixed: 41.5% rated them as "moderately appreciated." This may reflect a tension between their evaluative role and their pedagogical value—some students likely saw them more as constraints than learning tools.

Adherence to the online format was very high: 83.2% deemed it appropriate. The alternation between videos and assessments was well received, though video engagement

varied. While 38.2% watched all videos, 22.5% viewed fewer than half, perhaps favoring transcripts or selecting content strategically based on assessment needs.

Use of supplementary resources remained low: 62.2% consulted fewer than half or none at all. This likely stems from the course design, where core content sufficed for success, reducing perceived need for extras.

### 2.4 Areas for Improvement and Future Perspectives

While results show strong engagement, they also reveal areas for improvement to enhance the learning experience. The satisfaction survey, though rich in insights, has not yet been systematically analyzed to inform the MOOC transition.

Three key areas for improvement emerge:

- **Optimization of assessments:** Transforming evaluations into genuine learning tools by incorporating more formative feedback and pedagogical explanations.
- **Better integration of video modules:** Given the partial engagement with video content, exploring shorter, interactive, or segmented formats could improve attention retention.
- **Enhancing the value of supplementary resources:** Increasing their appeal and accessibility to encourage deeper exploration of the provided content.

These adjustments will help optimize the learning model, using student feedback to strengthen the future MOOC's pedagogical impact.

## 3 Conclusions

This study makes a significant contribution to the literature on sustainability education by providing an in-depth analysis of the implementation of a mandatory SPOC and its potential transition to a MOOC format. While many sustainability MOOCs are designed for voluntary or specialized audiences, our SPOC stands out due to its mandatory nature within an academic curriculum, presenting a unique challenge in terms of pedagogical design. By comparing our SPOC with similar initiatives such as Stanford University's "Sustainability and Development" MOOC (2021) [22] and Harvard University's "Global Sustainability" MOOC (2022) [23], we have positioned our approach within an international context while highlighting the specific features of our program, especially its mandatory requirement, which will influence student engagement.

The results demonstrate that the SPOC model offers great potential for raising awareness about sustainability issues. However, to maximize this impact, it is crucial to facilitate its transition to a MOOC format that can address a wider audience. This evolution would better meet the needs of a heterogeneous audience, including students from other disciplines, professionals, and citizens wishing to self-learn. Adapting the program into a modular, remotely accessible MOOC with options for certification would offer greater flexibility and recognition of prior learning, in line with international recommendations on education for sustainable development (UNESCO, 2017; UNESCO, 2023) [24, 25].

This study also aligns with recent research by Ribeiro *et al.* (2022) [26] and Tisdell and Lee (2023) [27], who explored the impact of MOOCs on sustainability education

in higher education. These studies highlighted challenges in adapting content to diverse audiences and managing student participation in digital environments. One of the major contributions of our study lies in how we integrated insights from these works to design a pedagogical structure that addresses diverse needs.

Additionally, our approach aligns with UNESCO's recommendations for sustainability education, emphasizing the need to make this education accessible to a global and diverse audience (UNESCO, 2017; UNESCO, 2023) [24, 25]. Furthermore, our study supports the arguments made by Cortese (2003) [12] and Lozano *et al.* (2013) [20], who advocate for the integration of sustainability into academic curricula to strengthen its legitimacy and impact.

The transition from SPOC to MOOC thus represents a strategic lever to broaden access to education on socio-ecological transition at a global scale. Drawing on recent research by Yuan and Powell (2013) [28], and global initiatives such as those at EDHEC, UCLouvain, and UNEP [10, 21], this transition will enhance the inclusivity of sustainability education programs and contribute to achieving the Sustainable Development Goals (SDGs) globally. We have demonstrated that the shift to a MOOC would bridge existing gaps in the educational offering on sustainability and increase the global impact of sustainability education.

In conclusion, this study demonstrates that the implementation of a mandatory SPOC on sustainability and its transition into a MOOC represents not only a significant advancement in sustainability education but also a pedagogical model adaptable to various institutional and professional contexts. This approach will reinforce the strategic and global impact of sustainability education, while addressing the contemporary challenges of socio-ecological transition and the emerging needs for training in this domain.

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