Online Higher Education and Sustainable Development: A Systematic Review of Global Perspectives and Local Implications of Sustainable Online Learning

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Abstract

As online education platforms transform higher education globally, critical questions persist regarding complex relationships with sustainable development aims centered on accessibility, quality, inclusion, and transformation. This systematic review synthesized 15 recent studies analyzing the nexus of digital learning, sustainability, and equity from diverse disciplinary and geographic perspectives. Findings reveal multifaceted tensions alongside opportunities at this intersection. Although virtual modalities promise flexibility and continuity, risks include exacerbating exclusion for marginalized groups and eroding academic standards in pursuit of profits. Key debates highlight public versus private funding models, techno-optimist versus critical perspectives, and global platform integration versus localized context-responsiveness. Concrete policy, practice and research recommendations emphasize needs for: comparative assessment of diverse programs, accreditation encompassing sustainability competencies, pedagogical innovation and faculty support structures, and transdisciplinary perspectives attentive to on-the-ground complexities. With care and intention, online tools hold immense potential to democratize access and better prepare learners worldwide to cooperatively tackle pressing challenges. But technocratic assumptions must be balanced with sustained critical engagement toward equitable and socially responsible outcomes.

1. Introduction

Online and distance education has seen rapid growth and evolution over the past few decades[1]. As internet access and digital technologies have expanded globally, higher education institutions have adopted online platforms and modalities to increase access to educational opportunities [2]. This growth has implications for sustainable development, which emphasizes meeting the needs of the present without compromising the ability of future generations to meet their own needs [3–5]

Education is highlighted in the United Nations Sustainable Development Goals (SDGs) as both a standalone goal (SDG 4) and a means to achieve other economic, social, and environmental targets [6]. Specifically, SDG 4.3 focuses on equal access to quality technical, vocational, and tertiary education, including university [7,8]. Online and distance higher education can serve to increase

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accessibility and inclusion, but also risks replicating or exacerbating existing inequities if not thoughtfully implemented [9]. Questions of the sustainability impacts of digital learning intersect with broader discourses about the purpose and responsibilities of higher education institutions [10]. As online enrollment rises, critical analyses are needed regarding if and how it can democratize access or reinforce exclusion [11,12].

A systematic review of the current higher education and sustainability literature reveals several common themes and tensions. Many studies highlight the potential benefits of online education for increasing accessibility, flexibility, and affordability – dimensions central to education equity and social sustainability [13]. Critiques point to the risk of prioritizing profits over pedagogy with the growth of massive open online courses (MOOCs) and other private sector providers in the higher education space [14]. Questions also remain regarding effectiveness for learner success online versus face-to-face [15]. Most research focuses on a specific program, platform, or country/region. As online higher education continues evolving, additional comparative studies can illuminate effective policies and practices[16]. There remains a need for further integration of insights across disciplinary perspectives spanning education, development studies, sustainability science, and information and communication technologies for development (ICT4D)[17].

1.1. Access, Equity, and Capabilities

A predominant focus in the literature is on implications of online higher education for accessibility and equity. Studies highlight the ability to reach non-traditional and marginalized students, such as those who face geographic barriers, have family or work obligations, or face discrimination on-campus [18]. Flexibility in time and space is emphasized as a major benefit, allowing students to access education at their convenience without geographic relocation [19]. This aligns with the capabilities approach notion of equal opportunities to achieve valued beings and doings regardless of circumstance [20].

However, studies also critique assumptions that increasing access automatically translates to more equitable participation. Several find online tools often reflect dominant languages, cultures, pedagogies, and technologies which may be unfamiliar or uncomfortable to diverse learners [21]. Unequal access to infrastructure, devices, skills, and bandwidth across geographic and socioeconomic groups also affects who benefits [22]. MOOCs and open educational resources (OERs) aim to expand access but tend to attract students already well-educated rather than those facing greater barriers [23]. Examining capabilities requires looking beyond physical admission to structural factors shaping meaningful participation for diverse publics once enrolled [24]

1.2. Economic Sustainability Tensions

Tensions around economic models feature prominently regarding the nexus of public/private interests, institutional funding constraints, and learner costs [25]. Proponents argue economies of scale from digital delivery alongside learner demand make online higher education critical for institutional viability [26]. Partnerships with MOOC platforms like Coursera and EdX are touted for generating new revenue streams [27]. However, others warn shifting funding models around online education risk eroding academic quality and rigor in pursuit of profits, reflecting neoliberal ideologies rather than pedagogical needs[28].

Debates similarly continue around cost and debt implications for learners. Flexible and self-paced programs are promoted as more affordable options [29]. Yet, public funding per pupil is often lower for online components, shifting costs to learners through tuition and fees [30]. Retention also remains an issue with higher dropout rates commonly reported for fully online

programs [31]. High debts and low completion may undermine economic sustainability goals for individuals and societies. Open access models attempt alternative funding structures but face questions around viability at scale[32].

1.3. Effectiveness and Learning Outcomes

A third active debate relates to the effectiveness of online modalities for ensuring quality learning outcomes. Satisfaction rates are generally high in institutional surveys, which cite convenience and flexibility as major advantages [33–35]. However, more critical assessments argue common shortcomings in instructional design negatively impact learner engagement and academic performance. For example, means of teacher-student interaction are often limited and emphasis placed on static, text-heavy content delivery[36]. Technocentric designs also frequently privilege tools over pedagogy without strategies adapted for diverse learners[37]. Comparative metrics on student success, such as assignment scores, grades, and test results, provide mixed results on relative outcomes between online, blended, and face-to-face modalities [38,39].

1.4.Links to Sustainability Literacy

Lastly, a smaller subset of literature examines online higher education specifically in relation to sustainability literacy and competencies [40]. Goals outlined in declarations like the COPERNICUS Charter emphasize universities' responsibilities to model sustainability across campus operations and teaching [41]. E-learning is critiqued for perpetuating unsustainable consumption patterns around devices, energy, and waste [42]. However, studies also highlight benefits for modeling sustainability values like cooperation, anticipation, and system-thinking which translate across topics [42]. For example, digital forums allow learners to connect classroom concepts to real-world sustainability issues in their communities [43]. Scenario activities likewise help students envision and critically assess alternative futures [44]. These align with transformational goals for learners to move beyond discipline-specific skills towards holistic critical thinking [45].

online and distance higher education brings opportunities and tensions related to sustainable development aims around accessibility, inclusion, capabilities, costs, and quality learning [46]. As access continues expanding, further research is needed examining if and how it translates to meaningful participation and outcomes [47]. There is also space for greater integration across disciplinary perspectives to develop holistic understandings of relationships between emerging digital education ecosystems and local to global sustainability priorities[48]. Comparative assessments can illuminate effective policies and practices across institutional models.

2. Materials and Methods

2.1.Search Strategy and Selection Criteria

This systematic review strictly adhered to the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [49], ensuring a comprehensive and transparent approach. The research protocol was meticulously designed following the specifications in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) statement [50] and was duly registered with PROSPERO (Registration Number: CRD42023491235).

An extensive and methodical search strategy was executed across various reputable databases, including but not limited to: Education Resources Information Center (ERIC), Scopus, Web

of Science, PubMed, and Google Scholar. The search strategy involved a meticulous combination of relevant keywords and controlled vocabulary (e.g., MeSH terms) related to online higher education, sustainable development, global perspectives, and local implicationsthe detailed search strategy described in tabale 1. Additionally, a systematic review of references within the selected articles was conducted to ensure comprehensiveness.

Table 1: Detailed Searching Strategy.

Database	Search Terms
Pubmed	("education, distance"[mesh] or "education, online"[mesh] or elearning or "online learning" or "virtual learning") and ("sustainable development"[mesh] or sustainability or "environmental sustainability") and (higher education or university or college) and (global perspectives or international or local implications)
Medline	Same as pubmed
Embase	'Distance education'/exp or elearning or 'online learning' or 'virtual learning' and 'sustainable development'/exp or sustainability or 'environmental sustainability' and higher education or university or college and global or international or local implications
Web of science	Ts = (elearning or "online learning" or "virtual learning") and ts = (sustainability or "sustainable development") and ts = (higher education or university or college) and ts = (global or international or local implications)
Cochrane library	(elearning or "online learning" or "virtual learning") and (sustainability or "sustainable development") and (higher education or university or college) and (global or international or local implications)
Ieee xplore	("distance education" or elearning or "online learning" or "virtual learning") and ("sustainable development" or sustainability) and (higher education or university or college) and (global or international or local implications)
Scopus	(title-abs-key (elearning) or title-abs-key ("online learning") or title-abs-key ("virtual learning")) and (title-abs-key (sustainability) or title-abs-key ("sustainable development")) and (title-abs-key (higher education) or title-abs-key (university) or title-abs-key (college)) and (title-abs-key (global) or title-abs-key (international) or title-abs-key (local implications))

2.2.Eligibility Screening

Following the removal of duplicates, eligibility screening was carried out by two independent reviewers (A.S.A. and W.B.M.B) in two stages: an initial assessment based on title and abstract, followed by a thorough evaluation of the full texts. Inclusion criteria encompassed studies focusing explicitly on the intersection between online higher education and sustainable development from global and/or local perspectives. Studies exploring various aspects such as environmental impact, socio-economic implications, pedagogical approaches, and technological innovations were considered. Exclusion criteria involved studies lacking relevance to the theme, opinion pieces, any discrepancies during the screening process were resolved through discussion and consensus between the reviewers.

2.3.Data Extraction

The primary aim of this systematic review was to analyze the various global perspectives and local implications of online higher education on sustainable development. Data extraction was conducted independently by multiple reviewers (A.S.A., H.M.A.M), emphasizing pertinent information from the included studies, including study characteristics, methodologies used, key findings related to the nexus of online education and sustainable development, and any nuanced local implications identified. Attempts were made to contact study authors for additional or missing data to ensure a comprehensive analysis. Moreover, any potential overlap or duplicity in the findings between studies was carefully assessed and reconciled through consultations with the respective study authors.

During the first database search, 4521 papers were discovered. After removing duplicates, 531 articles were evaluated for title and abstract, with 106 being rejected. Of the remaining 216 manuscripts, 15 were eventually chosen for full-text examination[51–65]. Figure 1 shows the PRISMA flow diagram.

2.4. Quality Assessment

The reviewer conducted a thorough evaluation of the methodological quality and risk of bias of all eligible studies. We evaluated all studies as an independent observational cohort, by using a modified version using ROBVIS2 it was developed during the Evidence Synthesis Hackathon, This web app is built on the ROBVIS R package [66]. Discrepancies in the assessment were resolved through consensus.

2.5. Data Analysis

The data analysis for this systematic review employed a mixed-method approach, combining narrative synthesis and thematic analysis

- Narrative Synthesis: This qualitative synthesis methodology involved summarizing and interpreting findings from the included studies, focusing on the global perspectives and local implications of online higher education in fostering sustainable development. It allowed for a descriptive synthesis, highlighting diverse viewpoints and implications for various stakeholders.
- Thematic Analysis: Utilizing thematic analysis, common themes, patterns, and implications observed across the selected studies were systematically identified and categorized. This involved coding the findings related to the global-local interface of online higher education and sustainable development, facilitating a nuanced exploration of connections, variations, and potential challenges or opportunities within these themes.
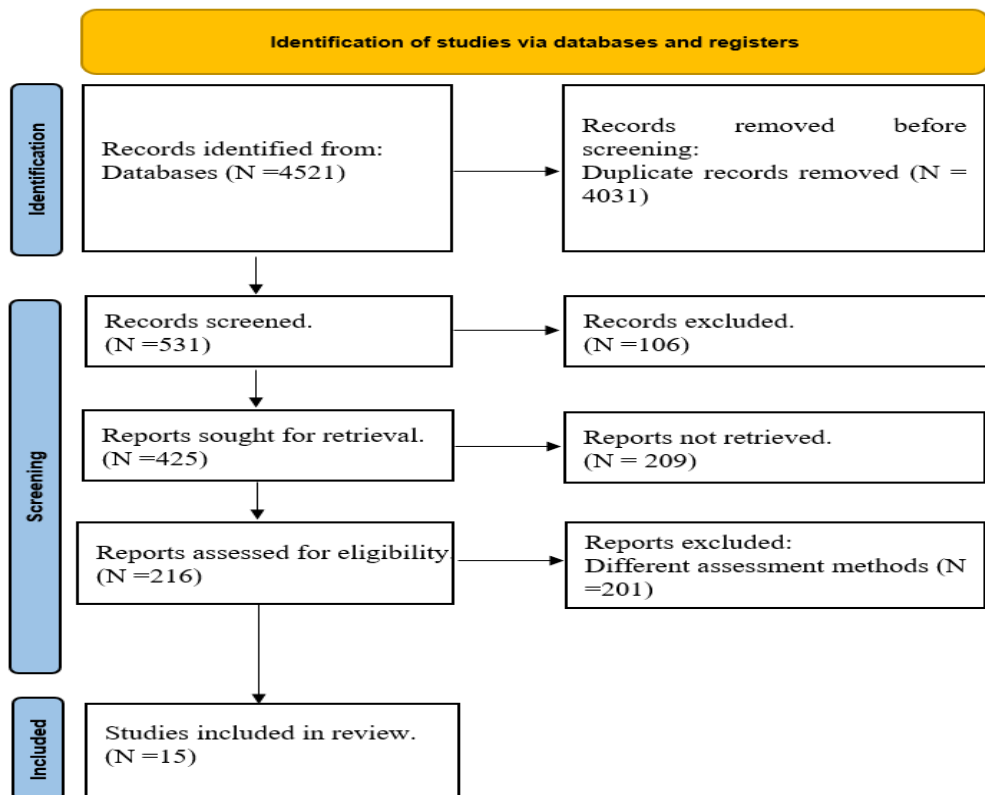

Identification of studies via databases and registers

Identification

Records identified from:
Databases (N =4521)

Records removed before screening:
Duplicate records removed (N = 4031)

Screening

Records screened.
(N =531)

Records excluded.
(N =106)

Reports sought for retrieval.
(N =425)

Reports not retrieved.
(N = 209)

Reports assessed for eligibility
(N =216)

Reports excluded:
Different assessment methods (N =201)

Included

Studies included in review.
(N =15)

Figure 1: PRISMA Flow Diagram[51–65].

3. Results

3.1. The Quality Assessment

The risk of bias assessment across the reviewed studies suggests an overall low level of bias in various domains. Kamkankaew. et al. (2023) demonstrated consistently low risks in the randomization process, deviation from intended intervention, missing outcome data, measurement of the outcome, and selection of reported results, contributing to an overall low risk of bias. Conversely, the study by Anderson, T., & Dron, J. (2011) exhibited high risks in randomization and deviation from the intended intervention, raising concerns about the reliability of the findings. The concerns persist in some aspects of missing outcome data, measurement of the outcome, and selection of reported results, resulting in an overall high risk of bias for this study. Zhang, Hongfeng, and Yumeng Zeng. 2022 showed some concerns in the randomization process, but overall, the risks in deviation, missing outcome data, measurement of the outcome, and selection of reported results were low, leading to a low overall risk of bias. The remaining studies, including Krishnan (2023), Hajdukiewicz (2020), Innab A, Alqahtani N (2023), Findler et al. (2019), Jarillo et al., (2019), Mondragon. et al. (2023), Ahmad. et al. (2023), Fülöp et al., (2022), Trevisan et al. (2023), Alam et al. (2023), Hueske et al. (2022), and Fülöp, et al. (2022), consistently demonstrated low risks across all assessed domains, indicating a generally favorable methodological quality with minimal potential for bias in these studies.
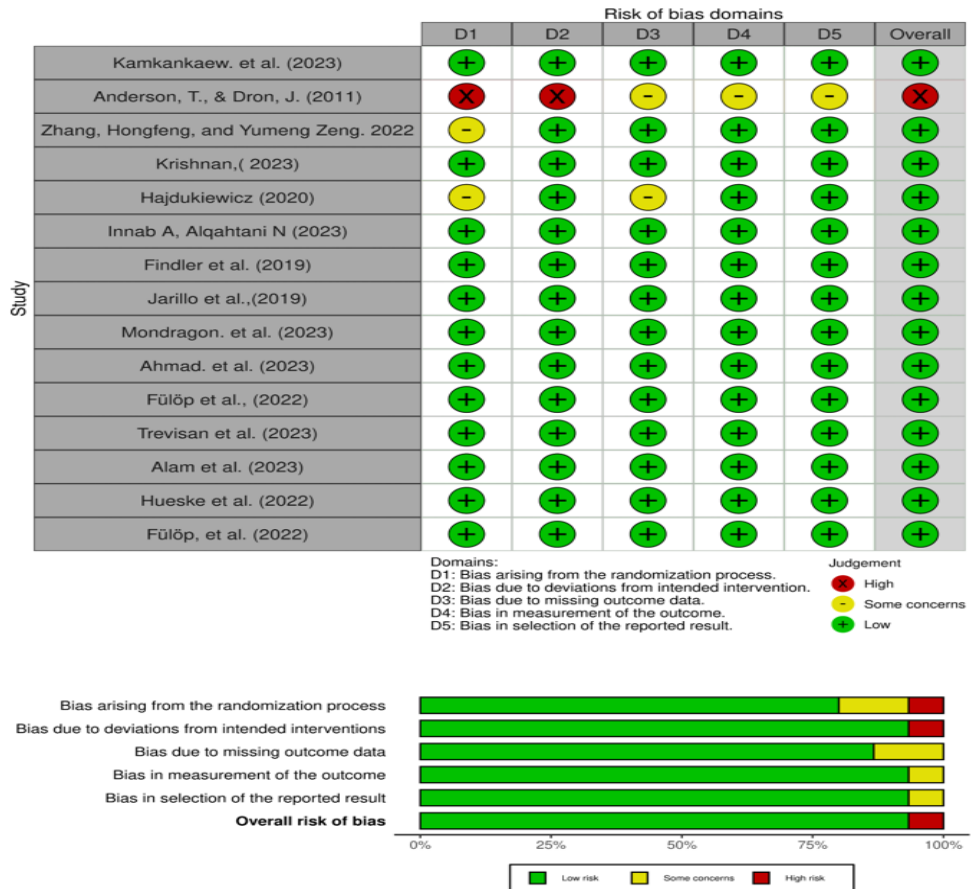
Figure 2: Summary of Risk of Bias[51–65].

3.2. Main Outcomes

The main outcomes of the diverse studies showcased here encapsulate a multifaceted landscape within higher education. These findings, grouped into four thematic categories, highlight pivotal aspects steering educational paradigms, sustainability integration, challenges in technology adoption, and student perspectives. Across studies exploring educational approaches and technological integration, discussions unveil the intricate layers of pedagogical design and the imperative balance between technology and learning experiences. Concurrently, investigations into sustainable development in education underscore the urgent need for curriculum evolution and institutional policies fostering responsible global citizenship. Moreover, an analysis of challenges in educational technology adoption surfaces critical barriers impeding the seamless integration of digital tools into academic settings. Finally, insights into student attitudes and satisfaction elucidate the nuanced perceptions and diverse experiences influencing digital education acceptance. These thematic categories collectively paint a comprehensive canvas of the multifaceted dynamics shaping contemporary higher education landscapes.

1. Educational Approaches and Technological Integration

Pedagogical Exploration: Studies like Anderson, T., & Dron, J. (2011); Zhang, Hongfeng, and Yumeng Zeng. (2022); Hueske et al. (2022) delve into various educational pedagogies and the integration of online technology. They explore the learning experiences shaped by different pedagogical approaches and emphasize the need for balanced integration of technology in education, aligning it with sustainable development values.

2. Sustainable Development in Education

Sustainable Curriculum: Several studies, such Kamkankaew. et al. (2023); Findler et al. (2019); Jarillo et al., (2019); Mondragon. et al. (2023), focus on the integration of sustainability principles into higher education institutions. They highlight the need for curriculum redesign, teacher training, and institutional policies to prepare students for societal challenges and foster responsible global citizens.

3. Challenges and Adoption of Educational Technology

E-Learning Challenges: Ahmad. et al. (2023); Fülöp et al. (2022); Trevisan et al. (2023) identify challenges in e-learning adoption in higher education. Factors such as technical support, infrastructure readiness, and faculty IT skills are highlighted as crucial barriers affecting the acceptance and adoption of educational technologies.

4. Student Attitudes and Satisfaction

Student Perspectives: Studies nnab A, Alqahtani N (2023); Alam et al. (2023); Fülöp, et al. (2022); Krishnan, (2023); Hajdukiewicz (2020) delve into student attitudes, satisfaction, and motivations in e-learning contexts. They explore factors influencing satisfaction, motivations, and attitudes towards digital education, highlighting disparities in access and the influence of gender, prior exposure, and socio-economic background on student perceptions.

Table 2: The Extraction Table[51–65].

Study	Study Design	Intervention/ Aim	Outcomes	Key Findings
Kamkankaew. et al. (2023) [51]	Review academic article	Integration of macro-marketing and circular economy principles	Producing socially responsible and environmentally conscious marketing professionals	- Thai higher education institutions need to integrate macro-marketing and circular economy principles for skilled marketers and responsible global citizens. - Strategies include curriculum redesign, faculty development, industry collaboration, and experiential learning. - The integrated system prepares students for sustainable business practices and societal challenges.
Anderson, T., & Dron, J. (2011) [52]	Conceptual analysis	Examination of three generations: cognitive-behaviorist, social constructivist, and connectivist pedagogy	Explores the learning experiences encapsulated in the learning design based on different pedagogical approaches	High-quality distance education leverages all three generations (cognitive-behaviorist, social constructivist, and connectivism) based on learning content, context, and expectations.
Zhang, Hongfeng, and Yumeng Zeng. 2022[58]	Exploration and Analysis	Integration of Online Technology	Instrumental & Humanistic Values in Education for Sustainable Development	The study explores the integration of online technology in Education for Sustainable Development (ESD). It compares this intervention with traditional education methods to understand the impact on instrumental and humanistic values within ESD. The findings emphasize the necessity for a balanced approach, considering humanistic values and rationalizing technology to achieve a more comprehensive ESD.

Study	Study Design	Intervention/ Aim	Outcomes	Key Findings
Krishnan,(2023) [59]	Qualitative Research	Not applicable (Observational study)	Determinants of student outcomes: Teacher, school administrator, district, student, parent, and pedagogy	Equity gaps attributed to deficit thinking in school professionals, lack of support for parents/students needing the most help, limited teaching practices
Hajdukiewicz (2020) [60]	Qualitative and quantitative analysis	Examination of sustainability content in MOOCs' syllabuses	Analysis of the integration of Sustainable Development Goals (SDGs) into higher education curriculum, specifically MOOCs	- Most SDGs are represented in MOOCs' content, but some topics like "Zero hunger" and "Peace, Justice, and Strong Institutions" require more inclusion in curricula.
Innab A, Alqahtani N (2023) [61]	Cross-sectional, descriptive	satisfaction, motivation, and access to technology tools	Satisfaction with e-learning, technology access, e-learning motivation	Nursing students were somewhat satisfied with e-learning, had access to required technology, and moderate e-learning motivation. Technology access and e-learning motivation jointly explained 30.4% of satisfaction variance. E-learning motivation partially mediated the relationship between technology access and satisfaction with e-learning. Previous e-learning experience was associated with higher satisfaction.
Findler et al. (2019) [62]	Systematic Literature Review	Conceptualize impacts of HEIs on Sustainable Development	Identified six impact areas of HEIs on SD	- Focus on case studies, lack of holistic perspective in analyzing impactsHEIs' activities may affect, society, environment, and economy,Highlighted responsibility of HEIs in fostering sustainability.
Jarillo et al.,(2019) [63]	Analysis	Implementation of online engineering education, addressing carbon footprint, geographical barriers, social inclusivity, and complete accessibility to the educational environment.	Discusses the impact on Goal 4 (inclusive and equitable quality education), Goal 10 (reduction of inequality), and Goal 13 (combating climate change and its impacts) through online education.	Highlights the role of online education in achieving SDGs, emphasizing reduced carbon footprint, bridging geographical gaps, and enhancing accessibility to education for individuals globally. Case study of Universidad Internacional de La Rioja showcases success with 100% online methodology and its impact on approximately 42,000 students worldwide, aiding those with reduced mobility and dispersed locations.
Mondragon. et al. (2023) [64]	Cross sectional study	To analyze the integration of Education for Sustainability (ES) in teaching staff at the University of the Basque Country	Teacher perceptions on ES integration	- 71.22% of teachers incorporate ES into their teaching, mainly focusing on "Environmental awareness and energy" and "Social commitment" themes. - Key competences mentioned were "training of professionals committed to society" and "critical thinking and ethics." - Teachers less familiar with the 2030 Agenda expressed sustainability's minimal relevance to their teaching (28.78%). - Factors like institutional sustainability policy, teaching expertise, and use of active methodologies influence the integration of sustainable development competences in higher education.
Ahmad. et al. (2023) [65]	Literature Review	To review challenges & limitations in eLearning acceptance & adoption in higher education	- Challenges in eLearning acceptance and adoption	- Lack of technical support, awareness, institution readiness, quality online course content, less IT skill of faculty in early years are challenges. - Factors affecting adoption: self-efficacy, financial, technological factors, pedagogical learning, socio-economic evolution, digital competence, and compatibility, lack of technological infrastructure.
Fülöp et al., 2022[53]	Questionnaire survey	Factors stimulating university students' tech acceptance	Analyzing factors influencing tech acceptance among students	- External factors showed no influence on perceived usefulness among students. - Perceived ease of use did not influence behavioral intention to adopt new technologies. - E-learning satisfaction linked to academic success among Romanian students during the pandemic. - Validation of basic variables in the Technology Acceptance Model (TAM).
Trevisan et al. (2023) [54]	Multi-methods approach including quantitative bibliometric review and qualitative content analysis	Explore how digital transformation (DT) can contribute to sustainability in Higher Education Institutions (HEIs)	Identified the state of the art, theoretical perspectives, and future research insights in the intersection of DT and sustainability in HEIs	Three areas of current research: ensuring sustainability competencies through DT, smart and sustainable campus approaches, and theorization of sustainability in higher education through DT. Theoretical perspectives were divided into seven main clusters. Five research lines for further studies on DT towards sustainability were identified.

Study	Study Design	Intervention/ Aim	Outcomes	Key Findings
alam et al. (2023)[55]	Semi-structured interview questionnaire based on the ABC Model of Attitudes	Examining university students' attitudes toward digitalizing higher education in Bangladesh	Attitudes of students, influenced by gender, prior exposure to digitalization, and socio-economic background	Most students hold positive attitudes toward digitalization, but discrepancies in access to digital facilities affect attitudes. Those with access generally hold positive attitudes, while those without access tend to hold negative attitudes despite acknowledging the importance of digital education. Gender, prior exposure, and socio-economic background significantly influence students' attitudes.
Hueske et al. (2022) [56]	Exploratory	Explored E-Learning mechanisms and SDG coverage in MOOCs within Nordic Principles for Responsible Management Education (PRME) member institutions.	Identified various E-Learning methods used by Higher Education Institutions (HEIs) focusing on Education for Sustainable Development (ESD). Analyzed 30 Massive Open Online Courses (MOOCs) to understand the coverage of Sustainable Development Goals (SDGs).	HEIs employ diverse blended and online learning strategies for formal and non-formal ESD. MOOCs from Nordic HEIs predominantly cover specific SDGs (9, 13, 11, 16) but lack content on SDG 2 due to the Nordic countries' developed economy status, where certain topics are often considered political or societal priorities. Business schools, especially Nordic UN PRME members, contribute to SDGs through their MOOCs.
Fülöp, et al. (2022)[57]	Observational (Survey-based)	Analyze teachers' acceptance of new technologies and its impact on wellbeing and university sustainability	N/A (Survey-based)	- Discontents among teachers regarding adapting to new technologies Personal discomfort in adopting new technologies Wellbeing significantly influences job satisfaction and teachers' involvement in sustainable development

4. Discussion

As digital learning platforms transform higher education ecosystems globally, critical questions persist regarding complex relationships with sustainable development priorities. This systematic review synthesized 15 recent studies analyzing the nexus of online education, sustainability, and equity from diverse disciplinary and geographic perspectives. The aggregated evidence reveals multifaceted tensions alongside emergent opportunities at the intersection of these domains.

Thematic Landscapes

Four salient, interrelated themes emerged across the literature: (1) educational approaches and technological integration, (2) sustainable curricula and institutions, (3) adoption barriers and challenges, and (4) student attitudes and satisfaction. Exploring these themes exposes intricate layers shaping contemporary digitally-mediated pedagogies, learning experiences, and sustainability outcomes.

For instance, while MOOCs and OERs hold promise to increase flexible access, questions arise whether learning analytics truly capture meaningful participation for marginalized groups versus merely expanding enrolment [67]. High satisfaction ratings likewise may primarily reflect the convenience priorities of already privileged subgroups rather than equitably serving all [68]. Profit-seeking privatization motivations also risk eroding academic standards and supports in pursuit of revenue growth [69].

Yet decidedly dismissing online options also discounts opportunities for continuity during crises like COVID-19 alongside responsiveness to legitimate learner demands for flexibility[70]. Connecting classroom curricula to real-world sustainability problem-solving can also nurture transformative competencies for systemic change[71]. And creative Commons licensing provides avenues to balance open access with compensation for high-quality design [72].

These complex trade-offs resist oversimplification, instead warranting nuanced engagement with on-the-ground constraints, unintended consequences, and power dynamics mediating digital learning ecosystems [73]. Discourses that fetishize innovation often obscure persistent pedagogical and infrastructural challenges [74]. For instance, comparative analyses on relative learning outcomes provide mixed results, suggesting need for greater attention to instructional strategies tailored for online environments[75]. Unique barriers likewise affect adoption across institutional types and socio-cultural contexts[76].

A key imperative emerging is thus centering critical social science, postcolonial, and sustainability perspectives to balance more technocratic educational and ICT4D literatures when theorizing equitable digitally-enhanced pedagogies [77]. This entails situating education not as an isolated technocratic enterprise but rather within wider societal power structures shaping how marginalized communities differentially experience promised benefits of innovation [78].

Tensions and Trade-Offs

Within complex landscapes outlined above, several pivotal tensions arise regarding risks, opportunities, and unintended consequences of digitization. Each domain encompasses multiplicity and nuances rather than binary techno-utopian versus neo-luddite positions.

One major axis highlights debates contrasting public good notions of higher education as a cooperative, democratic societal institution versus private good conceptions centered on individual economic returns on investments[79]. Open access, data privacy, academic freedom, public funding, and governance decisions hinge on where policymakers, institutions, faculty, and students fall within this spectrum [80]. For example, partnerships with private MOOC companies like Coursera promise revenue diversification but also raise accountability concerns if profit incentives erode rigorous standards [81].

A second tension contrasts techno-deterministic assumptions that digital tools inherently enhance learning, efficiency, and sustainability versus techno-skeptic doubts about whether adoption automatically yields meaningful improvements without holistic transformation [82]. For instance, a key debate examined here contrasts MOOC platforms claimed to expand access with critiques that superior completion rates of already privileged subgroups reflect more about socioeconomic status than online pedagogy [83].

Finally, contrasting policy visions disagree on whether sustainable digital education futures lie in homogenization through global platforms versus pluralization through localized context-specific tools and practices [84]. Centralized standardized models risk diminishing linguistic, cultural, epistemic diversity and self-determination, while decentralized community-based platforms raise viability questions around scalability and resources [85].

These complex trade-offs reveal multifaceted, context-dependent relationships between online learning and sustainability where win-win techno-optimist solutions rarely apply. Instead, careful navigation is required to steer between extremes in policy and practice.

Implications and Recommendations

Recognizing intricate tensions outlined above yields several implications for research, policy, and practice. First, comparative assessment of online program funding, effectiveness, accessibility, and sustainability impacts across institutional models can inform balanced regulatory frameworks [86]. Metrics here should combine big data learning analytics with rich

qualitative insights on marginalized learner experiences [87]. Special policy attention should focus reproducibility challenges and infrastructure deficiencies facing global South institutions [88].

Second, accreditation procedures should expand beyond employability and test scores to encompass holistic social responsibility and sustainability competencies [89]. This requires faculty support structures for communities of practice to reimagine curricula integrating such transformation priorities [90].

Third pedagogical innovation remains vital to actualize engaged, personalized learning through multimedia formats, structured interactions, and real-world problem applications [91]. Scaffolding reflection around underlying sustainability values and biases nurtures critical systemic thinking [92]. Workload policies should enable reasonable online class sizes for meaningful interactive instruction and feedback [93,94].

Finally, research should prioritize transdisciplinary perspectives spanning sustainability sciences, critical social sciences, comparative education, and ICT4D to advance more holistic understanding [95]. Nuanced mixed-methods combining learning analytics, surveys, interviews, ethnography, and scenario envisioning tools can capture multidimensional learner needs and outcomes [96,97]. Longitudinal assessments should track durability of sustainability competencies over time [98].

Such recommendations aim to steer an agenda advancing equitable and sustainable online education that avoids reactionary or techno-utopian extremes. The studies aggregated here thus highlight both cautious responsibility and hopeful possibility moving forward.

5. Conclusions

In an era of exponential higher education digitization, critical questions persist regarding complex relationships with democratized and transformative learning. The 15 studies systematically reviewed reveal multifaceted local-global tensions and trade-offs at the nexus of online platforms, pedagogies, and sustainability. Key messages resist one-size-fits all techno-solutionism, instead emphasizing needs for context-attentive policies and practices leveraging strengths while addressing persistent societal constraints. Suggested priorities aim to nurture an ecosystem fostering accessibility alongside high standards, financial viability with ethics, localized tools meeting global challenges, and technology balanced with interactive pedagogy for holistic skill-building - particularly among marginalized communities most in need of educational opportunities.

Through meticulous comparative assessments and transdisciplinary perspectives, research can continue elucidating possibilities and conditions for online higher education to enhance inclusion, flexibility, and sustainability competencies at scale. Such evidence-based insights can inform policies and teaching practices navigating digitization in alignment with justice aims, minimizing harms and barriers, while expanding access and better preparing learners worldwide to cooperatively tackle complex 21st century challenges. With care and intention, these tools hold immense potential to augment the public good valuing of higher education as an engine for more democratic, equitable, and sustainable futures.

Supplementary Materials: The following supporting information can be downloaded at PRISMA 2020 Checklist

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