

DOI Link: <https://doi.org/10.82044/OJCNZ>

Vol.411, Issue.3, Part.1, Mar 2026, PP.106-130

Received November 2025 Accepted February 2026 Published March 2026

Mapping Research of SDG4 in Higher Education: Curricula, Competencies, Digitalization, and Cross-SDG Synergies

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Abstract

As the Sustainable Development Goals (SDGs) enter the last third of the 2030 Agenda journey, there is a need to offer review and critical reflection of the way that the SDG4 Target 4.7, as related to sustainable development in higher education, has been explored from an academic point of view. The objective of this study is to present academic awareness of scientific research through identification and systematizing emerging research clusters which have main research themes, trends and perspectives. This exploratory study follows a systematic literature review guided by the PRISMA approach, and a qualitative (thematic) analysis of papers. The thoughtful thematic analysis identified four clusters in this study: Curricula, Competence, Digitalization and Symbiosis of the SDG4, and other SDGs that advance discourse on sustainable university practices. We concluded that (1) the research related to SDG4 Target 4.7 began much later, (2) behind scientific productivity lies scarce knowledge, (3) few countries (universities) report on the progress of higher education towards sustainability, (4) comparative studies between higher educational institutions are lacking, and (5) the transformative role of universities is not recognized. According to science-based solutions the scientific community and policy makers must have a collaborative approach, address simultaneously the same concerns with a holistic approach and use proven techniques from quality management. Thereby maintaining a balance between value, risk and cost throughout the value chain. Thus, establishing a problem-solving strategy which includes an analytics framework that includes descriptive, diagnostic, predictive, prescriptive analytics and flow of quality in conducting the 2030 Agenda. The novelty of this paper lies in the first attempt to provide an overview and systematization of the papers that explore the SDG4 in higher education, and the presentation of them in four research clusters. Future research needs to be inclined towards other clusters for research because at least four more clusters remain to be researched. These are namely a Framework for higher education institutions, sustainable Teaching and Learning, Indicators and Metrics related to SDG4.

Keywords: SDGs, SDG4, quality education, education for sustainability, Target 4.7. Agenda 2030, curricula, higher education, competences, digitalization

Introduction

Sustainable development (SD) is one of the most important real concepts of the second half of the 20th and the beginning of the 21st centuries. It was placed in the struggles of great ecological crisis, uncontrolled globalization and the emergence of advanced Information Communication Technologies (ICTs) which have contributed to ecosystem destruction; hence threatening life on earth (Mróz *et al.*, 2018). The early beginnings of the concept of SD were first noticed from an environmental perspective in 1713. Later it was seen from a societal perspective at the end of 20th century and culminated with the Paris Climate Agreement and the UN 2030 Agenda for Sustainable Development in 2015 (Bergman *et al.*, 2018).

Sustainability science emerged in the early 2000's as a new academic discipline aimed at addressing complex sustainability challenges (Kudo *et al.*, 2018). The concept of "sustainability science" was initially introduced by the National Research Council in 1999 and later referred to as "the science of sustainable development". It emphasized the interactions between society and the natural environment (Fang *et al.*, 2018). Broadly speaking, sustainability seeks to reconcile growing environmental concerns with socio-economic goals through active collaboration amongst local communities, learners, educators and other stakeholders (Kioupi and Voulvoulis, 2019).

In 1987 the World Commission on Environment and Development published Our Common Future, the Brundtland Report, for the United Nations. This defined SD as development that "meets the needs of the present without compromising the ability of future generations" (Glavič, 2020, p. 2). Building on this concept, the notion of corporate sustainability has since been developed (Abello-Romero *et al.*, 2023).

The concept of Education for Sustainable Development (ESD) was first introduced internationally by UNESCO and UNEP (Ashraf and Faisal, 2020). It has been highlighted in several global and national initiatives including Agenda 21 from the 1992 Earth Summit which, in chapter 36, emphasized the promotion of education, public awareness, training for balanced and sustainable development and environmental protection (Mróz *et al.*, 2018, p. 2). Additionally, the 1994 COPERNICUS charter developed by the Conference of European Rectors addressed environmental issues through coordinated university studies. Later, the 2002 Ubuntu Declaration on Education, Science and Technology for SD was endorsed by major academic institutions worldwide such as the Third World Academy of Sciences, the United Nations University, the International Association of Universities and the Science Council of Asia among others (Ashraf and Faisal, 2020).

Higher education institutions (HEIs) have an essential role in sustainability depicted as the goal of SD in addressing environmental, social and economic challenges. In recent decades the concept of a sustainable university has become a focal point of global discourse throughout the teaching and learning process, research centers, educational practices, the culture of sustainability, responsibility and accountability for next generation of professionals and implementing sustainable campus practices (Žalėniene and Pereira, 2021). The 21st century has seen universities with two

classic missions i.e. teaching and learning in education, and scientific research. A third novel mission exists with a commitment to society (Veres *et al.*, 2025).

Until now the most comprehensive approach to SD was adopted by 193 nations at the 70th Session of the UN General Assembly on the 25th of September 2015. This is presented as the 2030 Agenda for Sustainable Development (SDGs) with its 17 goals, 169 targets and 232 indicators on a global scale in a holistic approach (Bergman *et al.*, 2018). In detail these are SDG1: No Poverty, SDG2: Zero Hunger, SDG3: Good Health and Well-Being, SDG4: Quality Education, SDG5: Gender Equality, SDG6: Clean Water and Sanitation, SDG7: Affordable and Clean Energy, SDG8: Decent Work and Economic Growth, SDG9: Industry, Innovation and Infrastructure, SDG10: Reduced Inequalities, SDG11: Sustainable Cities and Communities, SDG12: Responsible Consumption and Production, SDG13: Climate Action, SDG14: Life Below Water, SDG15: Live on Land, SDG16: Peace, Justice and Strong Institutions and SDG17: Partnerships for said Goals.

These objectives address five areas i.e. the so-called 5xP: People (SDGs 1, 2, 3, 4, and 5), Prosperity (SDGs 7, 8, 9, 10 and 11), Planet (SDGs 6, 12, 13, 14, and 15), and Partnerships and Peace (SDGs 16 and 17) (Mroz *et al.*, 2018). In this context the SDGs are not only a goal for all governments, but also a guide for educational transformation worldwide (Ramos-Pla *et al.*, 2025).

Research Problem Statement

A Sustainability Report is a new form of the integrated reporting procedure in the field of SDGs (Bergman *et al.*, 2018). Progress towards the achievement of the SDGs can be considered through the sustainability reports from relevant institutions such as UNESCO, OECD, World Bank and the scientific publications. The 2023 UN Sustainable Development Progress Report indicates that at the midpoint of the 2030 Agenda, highlighted by the UN SDG Summit in 2023, only 15% of the SDGs are on track. Progress on over half of the targets remains weak and insufficient while 30% of the targets have either stalled or regressed (UNESCO, 2023). This is the main reason why the author of this study was encouraged to conduct this research with a special focus on the SDG4 target 4.7 in relationship to sustainable development and education for said development in higher education.

The results of an initial analysis of scientific publications related to SDG 4 in this study are presented as follows:

- During the period 2013–2017 research on SDG4 and SDG3 is well represented by universities in Austria (Körfigen, 2018).
- In the study of Chung *et al.* (2024) it is explicitly mentioned that the SDG4 and SDG3 were the most researched in the period of 2015 to 2023.
- The study of Rodríguez-Zurita (2024) indicates that SDG3, SDG4 and SDG11 are the most explored in scientific production.
- The empirical results from the study of Chaleta *et al.* (2021) showed that the SDG4 was less represented in the curricular units at the University of Évora in Portugal.

- The study of Asadullah *et al.* (2024) presented the broken interlinkages between SDG4 and SDG5 due to a hidden form of gender inequality in educational quality in South Asia.
- The attainment of SDG4 in Africa will remain elusive because the schools are not equipped to provide quality education, and the teachers require additional training (Nakidien *et al.*, 2021; Moses, 2024).
- The initiatives of 34 UNESCO Chairs across seven countries i.e. Germany, Iceland, Portugal, Slovenia, South Korea, Switzerland, and the United Kingdom have contributed to developmental efforts aligned with SDG4 and SDG17 (Bergman *et al.*, 2018).
- Makrakis *et al.*, (2025) examined the stages of concern experienced by academic teaching staff from nine universities in four Latin American countries—Argentina, Colombia, Costa Rica, and Mexico—regarding the integration of SDG4 into teaching, learning, and curriculum development.
- Economic sustainability was examined in the study of Ghosh and Pearson (2025) that shows that from six evaluated economic paradigms, the dominant economic paradigm - Neoclassical Welfare Economics, has the weakest alignment with the SDGs.
- While evidence-based research shows a strong engagement of higher education with SDGs, the full potential of HEIs has not yet been realized (Cantó, 2025).
- Achieving all SDGs including SDG4 is not as fast as expected and current assessment of the trajectory toward achieving the 17 SDGs by 2030 does not instill optimism and are still off track (Bergman *et al.*, 2018).

Our Research problem statement is to discover the key aspects and implications of the implementation of SDG4 target 4.7, sustainable development in higher education from the selected literature. The research objectives related to SDG4-ESD of this study are as follows:

- to present a systematic literature review for academic awareness and scientific research,
- to identify and systematize clusters of scientific productivity with the major research themes,
- to identify the perspectives that are viewed to a limited extent.

Literature review

The literature review will shed light on the bibliometric analysis about SDG4, empirical papers about progress towards SDG4 and student awareness of SDGs, and ESD.

Bibliometric analysis is a crucial tool for understanding the current state of scientific output. So, we identify the following bibliometric research studies on SDG4 presented in Table 1.

This study identified the empirical research paper which reveals that SDG4 is the top priority across all 30 public universities in 14 Arab countries (Abdalla *et al.*, 2024). Another paper, that assesses Serbia's progress towards SDG4, compares with the achievements of twelve other countries in the region, and with countries that

have made significant progress (Matović, 2024). HEIs in Spain and Latin America had called for urgent need to meet the challenges of the 2030 Agenda (Ramos-Pla *et al.*, 2025).

Table 1. Bibliometric research related to SDG4

References	Research period/date	Sources of data collection	Sample
Alonso-García <i>et al.</i> , 2019	2008-2019	WoS and Scopus	27 documents
	The emerging trend of Virtual Learning Environment as the main technology in the development of SDG4 is highlighted, in Spain HEIs.		
Sonetti <i>et al.</i> , 2020	2016 - 2019	Italian Network of Sustainable Universities	18 strategies
	The study examined 18 contemporary ESD strategies in practice, revealing that a primary focus on teaching and a predominantly top-down approach are common characteristics of SDG-related educational initiatives.		
García <i>et al.</i> , 2020	2015 - 2020	WoS and Scopus	240 publications
	SDG4 has been increasing in significance, with 2019 marking the peak year for scientific publications on the topic.		
Prieto-Jiménez <i>et al.</i> , 2021	2015-2020	Web of science (WoS)	342 publications
	This study focused on the SDG4 cluster, encompassing themes such as development education, gender, students, impact, strategy, quality education, and global citizenship education.		
Pedraja-Rejas <i>et al.</i> , 2023	2015–2022	WoS	111 publications
	In Latin America, research primarily follows two directions: one focuses on curriculum, extracurricular activities, projects, and pedagogical initiatives, while the other examines students' behaviors, perceptions, beliefs, concerns, and knowledge levels regarding issues related to the SDGs.		
Chung <i>et al.</i> , 2024	2015 - 2023	WoS	141 publications
	The SDG4 cluster revealed three main themes: the role of universities in promoting sustainability, sustainability in the context of COVID-19, and the challenges associated with its implementation.		
Rodríguez-Zurita <i>et al.</i> , 2024	2023	WoS and Scopus	118 publications
	The findings reveal a substantial shift from curriculum development to education for sustainable development, effectiveness and integration of service learning with community engagement, and acquisition of sustainable development competencies.		
Singh <i>et al.</i> , 2024	2001 - 2020	Dimensions database	20 511 documents
	The findings show that SDGs 3 and 7 had the most applications of AI, after that follows SDGs 4, 13, 11 and 16. United Nations is the country with most publications followed by China and UK. The dominant technological concepts were “Artificial Intelligence” and “Natural Language Processing”.		
Okulich-Kazarin <i>et al.</i> , 2024	2022-2024	Scopus	5000 sources, survey of 1104 students
	A survey conducted across eight universities in Poland, Kazakhstan, Slovakia, and Ukraine found that between 10.17% and 35.42% of students perceive AI as a potential threat to higher education, potentially undermining SDG 4.3, which pertains to providing a “safe” learning environment.		
Göçoglu, 2025	2024	Strategic Management in the Public Sector	121 records
	Findings from Turkey indicate that universities primarily prioritize SDGs 8, 16, 9, 11, and 4, each receiving attention from 40% or more of institutions. While most universities focus on sustainability from institutional and societal perspectives, environmental concerns are comparatively underemphasized.		

The students' awareness of sustainable development and their opinion on the implementation of SDGs in curricula at HEI in Krakow, Poland and Jordan shows a high level (Husban, 2025; Zwolińska *et al.*, 2022). The students in Slovenia,

Croatia, Bosnia and Herzegovina, Serbia and Montenegro support the significance of pro-environmental attitudes and IT skills aligned with SDGs 4, 12 and 13 (Alfirević *et al.*, 2024) while in Finland the students support holistic approaches and systems thinking (Kuusalu *et al.*, 2024).

Education for sustainable development

Higher education institutions (HEIs) play a pivotal role in advancing the international 2030 Sustainable Development Agenda. SDG4 seeks to “ensure inclusive and equitable quality education and to promote lifelong learning opportunities for all”. In addition, Target 4.7 specifically aims for that by 2030 with all learners acquiring the knowledge and skills necessary to foster sustainable development. This includes education for sustainable development, sustainable lifestyles, human rights, gender equality, peace, global citizenship and cultural diversity (Sonetti *et al.*, 2020).

Fuchs *et al.*, (2023) emphasizes the importance of integrating the SDGs into academic activities within Latin American universities, highlighting the need for partnerships between HEI’s and local communities including the public and private sectors. All this can be achieved as well as the extension of ESD knowledge beyond the classroom. Similarly, Nnam *et al.*, (2025) demonstrates that sustainability integration in accounting education can be reinforced through both foundational and contemporary theories. This includes the triple-bottom-line theory, systems theory and personal agency theory.

Sustainable development is supported and promoted through ESD. It is also referred to as education for sustainability, environmental education, or sustainability education (Mróz *et al.*, 2018). As a core component of SDG4, Target 4.7, ESD is critical for global sustainability. Thus, necessitating a rethinking of existing educational paradigms (Sánchez-Carracedo *et al.*, 2019; Mendonça *et al.*, 2025). Over the past decade calls for paradigm shifts in teaching, learning and thinking for a sustainable world have emphasized the need to rethink learning content, pedagogy and the educational environment (Greig and Priddle, 2019).

ESD addresses cognitive, social-emotional and behavioral dimensions to develop the key competencies learners need to engage effectively with all 17 SDGs (Husban, 2025). Science, technology, engineering and mathematics (STEM) are essential educational targets for sustainability competencies. Achieving Target 4.7 requires ensuring that educators themselves are both competent and confident in teaching sustainability. However, research from the University of Pennsylvania has revealed that many STEM educators hold a simplified and incomplete understanding of sustainability (Cordaro *et al.*, 2025). The Global Education Monitoring Report emphasizes that, more than any other target, SDG 4.7 engages with the social, humanistic and moral purposes of education (Sund and Pashby, 2018).

Key topics under SDG4 linked to ESD include lifelong learning, inclusive and diverse education, public funding for education, sustainability skills and competencies, ICT in education and youth empowerment (Hajdukiewicz and Pera, 2020). Muralidharan *et al.* (2022) highlight that in India SDG 4 aims to enhance

quality of life and living standards by ensuring access to quality lifelong education regardless of region, race, religion, color or caste.

HEIs have endorsed numerous declarations, charters and initiatives to strengthen ESD across curricula, research, collaborations and institutional operations (Glavič, 2020). While countries such as Spain, France, Brazil, India and China have successfully integrated ESD into teacher education programs, many other nations continue to lag in implementation (Cordaro *et al.*, 2025).

Research has also explored inclusive education such as access and completion rates for students with disabilities at a Spanish university (Espada-Chavarria *et al.*, 2020). Studies in China have examined the interplay between job autonomy, emotional demands, colleague support and burnout among administrative staff aligning with SDG4 and SDG8 (Lei *et al.*, 2023). Additionally, findings from the Vietnam National University indicate that both university reputation and academic quality, as key SDG4 concepts, significantly influence postgraduate enrollment decisions (Amoozegar *et al.*, 2025).

The author of the current study aims to address one gap in literature that will provide a major avenue for future research in this rapidly evolving field of inquiry for SDG4. So, with content and document analysis, extraction of the major research themes for SDG4 will be performed and grouped in the research clusters.

Methods

This study employed an exploratory research design with the aim of synthesizing recent academic advancements related to SDG4, Target 4.7, and ESD within higher education. A systematic literature review (SLR) was conducted following the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The review process consisted of three main stages: Identification, Screening and Eligibility/Inclusion as presented in Figure 1.

The initial stage involved a broad search for peer-reviewed journal articles, and review papers published in English between 1990 and 2025. This time frame was selected to capture both the early conceptual development of ESD, and the more recent surge in SDG-related research following the adoption of the 2030 Agenda. To ensure high academic quality the search was restricted to ten leading journals frequently referenced to in the field of sustainability education as identified by Tafese and Kopp (2025):

- Sustainability
- International Journal of Sustainability in Higher Education
- Environmental Education Research
- Journal of Teacher Education for Sustainability
- International Review of Education
- Education Sciences
- Sustainable Development
- Australian Journal of Environmental Education
- International Journal of Educational Development
- Journal of Geography in Higher Education

The initial search yielded 553 documents, including conceptual papers, empirical studies and review articles.

The second stage consisted of applying a keyword-based screening procedure to ensure relevance to SDG4 and ESD. The keywords used were: “Sustainable Development Goals,” “SDG4,” “Target 4.7,” “Education for Sustainable Development (ESD),” and “quality education.” Articles that did not explicitly address educational contexts, sustainability education, or higher education practices were removed at this step. After screening titles, abstracts, and keywords, 120 papers were retained for full-text assessment.

In the final stage, articles were evaluated in full against predefined inclusion criteria:

- The study addresses HEIs.
- The content relates directly to SDG4, Target 4.7, or ESD.
- The article contributes to one or more of the thematic areas identified as central to SDG 4.7 implementation:

- Curricula
- Competence development
- Digitalization
- Synergies between SDG4 and other SDGs

Exclusion criteria included papers focusing solely on primary or secondary education, general sustainability reporting without an educational dimension or framework for higher education institutions, sustainable teaching and learning and indicators and metrics related to SDG4. Based on these criteria, 95 articles were included in the final synthesis.

A qualitative thematic analysis was conducted to synthesize and interpret the retrieved papers. Data extraction involved coding each article for research purposes, methodological characteristics, educational context, main findings, relation to SDG4 and alignment with one of the emerging research clusters. The four resulting clusters, i.e. Curricula, Competencies, Digitalization and Synergies between SDG4 and other SDGs represent the most recurrent strands of research found in the selected corpus.

Cluster formation was informed by:

- Recurring themes appearing across multiple studies.
- The relevance of these themes to SDG 4.7 involving knowledge, skills, values and attitudes needed for sustainability.
- The potential of these clusters to capture developments in higher education practice, research and policy.

This methodological framework ensured a comprehensive and systematic review of scientific productivity on SDG 4.7 within higher education.

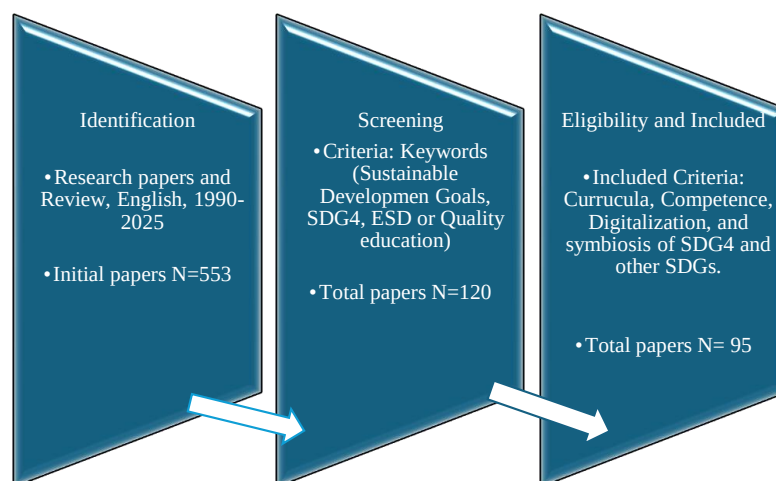


Figure 1. PRISMA flow diagram.

Results and Discussion

The review of existing scientific literature on SDG4 reveals four major thematic clusters as curricula, competencies, digitalization and the synergy of SDG4 with other SDGs.

Thematic Cluster Analysis - Cluster 1: Curricula (Table 2.)

Studies indicate that integrating sustainability into curricula remains a central focus in educational research. For instance, teachers in Polish schools' report familiarity with incorporating environmental protection into their teaching (Mróz *et al.*, 2018). Comparative research in the natural sciences curricula is limited with only one identified study analyzing approaches in Taiwan and Colombia (Molina *et al.*, 2021).

Thematic Cluster Analysis - Cluster 2: Competencies (Table 3.)

Competency based education has gained prominence particularly following the implementation of the European Higher Education Area (Albareda-Tiana *et al.*, 2019). Numerous frameworks for sustainability competencies have since been developed encompassing descriptive-analytical, solution-oriented, attitudinal, transdisciplinary, interpersonal and normative skills (Kudo *et al.*, 2018; Sánchez-Carracedo *et al.*, 2019; Kioupi and Voulvoulis, 2019). Recent studies also propose models for "new leaders" with competencies tailored to address complexity, urgency and challenges in sustainability contexts (Novy *et al.*, 2021).

Thematic Cluster Analysis - Cluster 3: Digitalization (Table 4.)

Educational technology, combining education and digital tools, is essential for achieving SDG4 by 2030. The rise of Industry 4.0 has led to Education 4.0 which applies physical and digital resources to address contemporary societal challenges (Sarango-Lapo *et al.*, 2021). Pedagogical applications using ICT are increasingly prevalent, and computational thinking is recognized as a critical skill across educational levels (Alonso-García *et al.*, 2019; Díaz-Lauzurica and Moreno-Salinas, 2019). ICT integration positively influences multiple SDG's, including SDG2, 3, 4, 5, 8, 9, and 10 (Kerras *et al.*, 2020).

Thematic Cluster Analysis - Cluster 4: Synergy of SDG4 and Other SDG's (Table 5.)

Education serves not only as a stand-alone goal (SDG4), but also as a driver for achieving other SDGs. Identifying and leveraging these synergies is increasingly important as the 2030 Agenda progresses. While studies highlight connections between SDG4 and several other goals, research exploring SDG4 in combination with SDG's 1, 2, 6, 7, 14, 15, 16, and 17 remains limited.

Overall, these clusters demonstrate that SDG4 research spans curriculum development, competent frameworks, digital transformation in education and interlinkages with other SDG's thus highlighting the multidimensional nature of education for sustainable development.

Table 2. Thematic Cluster Analysis - Cluster 1: Curricula

Thematic category of Cluster 1: Curricula	Design/methodology/sample	Short description/main research questions/implications	References
Integration of sustainability in the curricula	Exploratory and contextual content analysis/ 76 Nigerian universities	The findings indicate that accounting education in Nigeria has yet to align with initiatives supporting the 2030 Agenda, showing only limited incorporation of sustainability concepts within its curricula.	Nnam <i>et al.</i> , 2025
Integration of climate change education into the curriculum	Narrative interviews/ teachers from Indonesia	Teachers' perspectives on embedding climate change education into the curriculum highlight its complexity and underscore the need to categorize educators into four environmental identity types: master storyteller, early adopter, reluctant implementer and discouraged believer.	Zen <i>et al.</i> , 2024
Integration of sustainability in the curricula	Qualitative and quantitative analyses/15 public HEIs in Portugal	The planned strategies and objectives of Portuguese public HEI's show limited alignment with their own reported efforts to embed sustainability within teaching and curricula.	Duarte <i>et al.</i> , 2023
Integration of sustainability in the curricula	Theoretical study	This research outlines criteria for evaluating how appropriate sustainability frameworks are for integration across the curriculum, focusing on their relevance to existing programmes, clarity of language, compatibility with institutional contexts and underlying future-oriented assumptions.	Mair and Druckman, 2023
Transformative Sustainable Curricula model	Survey/ document analysis and interviews with education experts in Spain	The Transformative Sustainable Curricula model serves as a theoretical framework for identifying a degree of change such as adaptation, reform, transformation as well as the key transformative elements present in sustainability-focused geography curricula.	Granados-Sánchez, 2022
Integration of sustainability in the curricula	Case study/ Santo Tomas University, Colombia	This research outlines three essential phases required to successfully integrate Education for Sustainable Development (ESD) into an undergraduate environmental engineering program.	Acosta-Castellanos and Queiruga-Dios, 2022
Integration of sustainability in the curricula	Case study/ Saudi Arabia universities	The study adopts a micro-curriculum approach noting that dedicated sustainability courses are the most effective for fostering sustainability awareness. It also positions advanced personalized learning as a sustainability-related concept linked to SDG4.	Ashraf and Alanezi, 2020
Course on ESD	Theoretical study/ Key issues from projects and three international conferences	ESD curricula and courses should be structured into four categories: approach (integration of ESD in scope, policy, and collaboration), content (coverage of ESD across environmental, social, and economic dimensions), teaching (ESD methodologies, transformative learning, and capacity development) and organization (ESD-related metrics, documentation, and institutional structures).	Glavič, 2020
Sustainability Learning Model	Master program in Sustainability/Anglia Ruskin University (UK)	The model is a visualization of the elements: learning, teaching and content that are identified as important in sustainability context to address SDG Target 4.7.	Greig and Priddle, 2019

Table 3. Thematic Cluster Analysis - Cluster 2: Competences

Thematic category of Cluster 2: Competence	Design/methodology/ sample	Short description/main research questions/implications	Year/ Reference
Intercultural Communicative Competence	Literature review	The model provides a visual representation of key elements—learning, teaching, and content—recognized as essential within the sustainability context to support the achievement of SDG Target 4.7.	Tovar-Correal and Pedraja-Rejas, 2025
Environmental Education through Eco-Literacy	Mixed methods/Yıldız Technical University, Turkey	This study demonstrates the pivotal role of integrating eco-literacy into English language teaching classrooms, focusing on writing activities on their language development and awareness of environmental issues.	Kazazoglu, 2025
Systems Thinking for Sustainability Education	Simulation/ Polytechnic University of Madrid Spain	This study presents a didactic approach for students employing a Project-Based Learning methodology, aimed at developing competencies in systems thinking, interdisciplinary collaboration, interpersonal and team relationships, and tolerance for ambiguity and uncertainty.	Marcos-Sánchez <i>et al.</i> , 2022
Knowledge, skills, and attitudes	Quantitative and qualitative analysis/HEIs from 14 countries, mostly from Europe	This study introduces an innovative theoretical framework connecting knowledge, skills, and attitudes (KSA's) to UNESCO's Key Competences for Sustainability and specific SDG's, with a primary focus on SDG4, which corresponds to all identified KSA's.	De La Torre <i>et al.</i> , 2022
Students' Innovation Competences	Case study/Universitat Oberta de Catalunya, Spain	This study analyses achievement of students' innovation competences by considering two sustainable development goals SDG4 and SDG5. Students perceived that they were most proficient in innovation competences of perseverance, change management, problem-solving, and initiative.	Ferreras-Garcia <i>et al.</i> , 2021
Digital Competence	Survey/Gansu Agricultural University, China	University students reported positive perceptions of their digital competences particularly in areas such as information and data literacy, communication and collaboration, security and problem-solving.	Zhao <i>et al.</i> , 2021
Competency-based teaching and learning	Case study/ three Spanish universities	Integrating sustainability into the curriculum through active teaching and learning strategies—such as problem-based learning, project-oriented learning and interdisciplinary workshop enables future teachers to engage in transformative education by developing advanced competencies that help reduce the ecological footprint.	Albareda-Tiana <i>et al.</i> , 2019
Sustainability competency - ethical principles	Exploratory study /Engineering degree of the Spanish university system.	The findings reveal that among all degree programs the sustainability competence related to participation in community processes promoting sustainability is the least developed. However, the competence involving the application of ethical principles aligned with sustainability values in personal and professional behavior is the most prevalent.	Sánchez-Carracedo <i>et al.</i> , 2019
Competence	Case study/ University of Tokyo, Japan	Field-based courses can help cultivate essential skills for future sustainability experts. This includes the capacity to perform key competencies collaboratively rather than individually, an interdisciplinary perspective among researchers, a transdisciplinary approach to engaging with the broader environment and the development of empathy.	Kudo <i>et al.</i> , 2018

Table 4. Thematic Cluster Analysis - Cluster 3: Digitalization

Thematic category of Cluster 3: Digitalization	Design/methodology/sample	Short description/main research questions/implications	Year/Reference
Digital Communication	Exploratory study/ Bucharest University of Economic Studies, Romania	The digital transformation enhances students' access to learning, inclusivity, communication, and collaboration, aligning to SDG4. Digital communication tools influence positively students' engagement in a learning environment.	Petre <i>et al.</i> , 2025
Information and Communication Technology	Case study/ Czech private higher education institution	The study indicates that the impact of ICT skills and competencies on student performance depends on their integration with traditional teaching methods and students' existing digital abilities. Additionally, the influence of ICT tools varies across different subjects, and teachers' capability to effectively combine ICT and non-ICT activities plays a crucial role.	Milkova <i>et al.</i> , 2025
Blockchain Business Model	Qualitative research design/content analysis	The comprehensive Blockchain Business Model provides a pattern for transformation HEIs of the future and the "employable skills-seeking" proactive students.	Son-Turan, 2022
Blockchain Technology	Case study/ three universities in Serbia, Romania, and Portugal	Blockchain technologies enable higher education institutions to enhance teaching approaches, develop more effective learning platforms and record-keeping systems, and boost student motivation in collaborative work, engagement, and activities such as MOOC's, augmented reality, virtual reality, gamification and overall learning performance.	Bucea-Manea-Tonis <i>et al.</i> , 2021
Massive use of ICTs	Case study/ Spanish universities	The main results consist of the different emotional reactions among professors, establishing that ICTs allow the development of new skills, the introduction of new methodological proposals and the development of a positive attitude towards the use of digital tools to reach all students, aligning with SDG4. On the other hand, the use of ICTs caused an increase in anxiety, workloads and the need for ongoing training.	Rangel-Pérez <i>et al.</i> , 2021
Technology Enhanced Learning (TEL)	Survey/ HEIs in Azerbaijan	TEL applications—such as ICT tools, e-resources, and innovative pedagogical approaches—are particularly valuable for rapidly developing countries, supporting sustainable access to quality education in line with SDG4, as illustrated in the context of Azerbaijan.	Orozco-Messana <i>et al.</i> , 2020
Massive online open courses (MOOCs)	Survey/ University of Extremadura, Spain	The characteristics of MOOC's support the objectives of SDG4. For example, a MOOC on wastewater treatment was implemented in civil engineering higher education (SDG 6) in Spain thus demonstrating a successful educational initiative.	Gómez-Llanos and Durán-Barroso, 2020
Digital technologies	Theoretical study	The globalization of Mobile devices and Binomial Augmented Reality contribute to SDG4.	Del Cerro Velázquez and Méndez, 2018

Table 5. Thematic Cluster Analysis - Cluster 4: SDG4 and other SDGs

Thematic category of Cluster 4: SDG4 and other SDGs	Design/methodology /Sample	Short description/main research questions/implications	Year/ Reference
 	An exploratory, bibliographical investigation	This study examines how environmental education, within the framework of sustainability and geodetics, can address sustainability challenges from an ethical perspective. The findings underscore the ethical boundaries essential for achieving a sustainable future. The interconnectedness of SDG3 and SDG4 is highlighted as a strategic concern, requiring collaboration among policymakers, educators and civil society through key strategies such as enhancing public policies, promoting ethical education, encouraging innovation and fostering global solidarity.	Mendonça, 2025
 	Survey/ University in Ankara, Turkey	This study investigates the intricate relationships between student cynicism, student-university identification, academic self-efficacy and academic performance thus highlighting their relevance to both SDG4 and SDG8.	Tosun and Çetin, 2025
  	Qualitative research study/University campus in Ecuador	A review of national and international construction regulations in Ecuador highlights that physical accessibility is a fundamental right essential for inclusive education. At one Ecuadorian university inclusion was assessed at a moderate level. Implementing universal accessibility aligns with key principles of SDG4, SDG10 and SDG11.	Maldonado-Garcés <i>et al.</i> , 2025
 	Survey/30 HEIs in Arab region	The results of the multi-dimensional analysis reveal that SDG4 and SDG8 are top priorities for all universities. Furthermore, institutional governance and research productivity are key factors that drive universities' engagement with the SDGs.	Abdalla <i>et al.</i> , 2024
 	Survey/ G7 and E7 countries	The study indicates that the interaction between SDG4 and SDG13 in G7 and E7 countries promotes sustainable and effective climate action by influencing the ecological footprint. In G7 countries environmental degradation is driven by natural resource rents and ICT while economic complexity, human development and green technological innovation enhance environmental quality. In E7 countries, natural resource rents and economic complexity contribute to environmental degradation, whereas human development, ICT, and green technological innovation improve environmental outcomes.	Balsalobre-Lorente <i>et al.</i> , 2024
  	Empirical study/ Slovenia, Croatia, Bosnia and Herzegovina, Serbia, and Montenegro	This study examines the factors influencing university students' pro-environmental attitudes and self-efficacy, considering their use of and proficiency in information technology, in alignment with SDG4, SDG12 and SDG13.	Alfirević <i>et al.</i> , 2024
 	Qualitative research/ 18 HEIs in Chile	A review of strategic plans shows that all 18 universities analyzed have incorporated at least one SDG into their institutional strategies, with SDG4 and SDG9 being the most frequently included.	Abello-Romero <i>et al.</i> , 2023
 	Theoretical review and panel model/China	This review indicates a link between regional sustainability and higher education attainment. At the national level, sustainability demonstrates significant positive effects. In central China economic sustainability has a positive impact whereas in the western region economic and social sustainability exert stronger positive effects. Conversely, environmental sustainability shows a significant negative effect.	Liu <i>et al.</i> , 2022
 	Survey/HEIs in Portugal	Self-determination theory identified the relationship between the factors that motivate students to pursue a sustainable career in the hospitality and tourism industry. Strong relationships between academia and industry will enable the achieving of SDG4 and more sustainable careers aligning with SDG8.	Cesário <i>et al.</i> , 2022
  	Survey/Latin America (Andres Bello University located at Viña del Mar city)	This study promotes social sustainability by developing high-quality entrepreneurial education programs (SDG4) that ensure equal opportunities for men and women (SDG5), reduce gender disparities and enhance equitable access to entrepreneurship-driven opportunities in large-scale educational settings targeting socioeconomically emerging sectors (SDG10).	Contreras-Barraza <i>et al.</i> , 2021
 	Comparative exploration study/ 50 business schools (Europe, US and Asia)	Through content analysis this study reveals that business schools' sustainability reports show a positive correlation between priorities associated with SDG4 and SDG5.	Miotto <i>et al.</i> , 2019

Conclusion

Humanity, there is a need for a broad corpus of specific and detailed knowledge to accelerate worldwide progress related to sustainability and SDG4 with an aim to achieve “fit for purpose”. With the growth of knowledge-based society we should strengthen our capabilities, knowledge, skills, learning and institutions about all facets of sustainability. All of this with a view to ensuring a climate-resilient future and the wellbeing of the earth (Velkoska, 2021).

Unfortunately, it seems that academic productivity is lagging the regulations, policies, public promotions, conferences, public calls, global recommendations from UNESCO, UN, OECD and other relevant stakeholders.

As the SDG’s enter the last third of the 2030 Agenda journey, the aim of this study was to offer a comprehensive review and critical reflection of the way that the SDG4 has been explored from an academic point of view. This research brought initial insights, with the aim of strengthening intellectual debate about the non-alignment of the expectations of politicians and regulations (political efforts), with the real situation regarding the implementation of knowledge and its evaluation in relation to SDG4- ESD.

We conclude that (1) research related to SDG4 target 4.7 began much later (2) behind scientific productivity lies scarce knowledge (Momete, D. and Momete, M., 2021; Filho *et al.*, 2025), (3) few countries (universities) report on the progress of higher education towards sustainability (Cordaro *et al.*, 2025), (4) comparative studies between higher education institutions are lacking (Molina *et al.*, 2021; Okanovic *et al.*, 2021), and (5) the transformative role of universities is not recognized (Kohl *et al.*, 2022).

So, this research should be recognized as an urgent call, and kind invitation, for re-thinking the 2030 Agenda. It should include three essential approaches from quality management: maintaining a balance between value, risk and cost throughout the value chain (Grigg, 2021; Sadkowski and Jedynak, 2022; Tomov and Velkoska, 2022; Velkoska, 2024), establishing a problem solving strategy (Escobar *et al.*, 2021) that includes an analytics framework i.e. descriptive, diagnostic, predictive, prescriptive analytics (Bousdekis *et al.*, 2022) and “flow of quality” from the field of quality assurance. This would include quality of design, quality of conformance to design, quality of conformance in conducting the 2030 Agenda (Velkoska and Nuredin, 2023; Velkoska and Nuredin, 2024), and achieving the determined SDGs. Based on science-oriented solutions, the scientific community and policy makers must, both, have a collaborative approach and address simultaneously the same concerns with the holistic approach (Veres, *et al.*, 2024).

The novelty of this paper lies in the first attempt to provide an overview and systematization of the papers that explore the SDG4 in higher education by presenting them in four research clusters. The presented clusters in this study reflect the strands of research of the analyzed papers, and simultaneously, they present emerging trends on SDG4 which advance discourse on sustainable university practices. Hence, this offers actionable insights for institutional leaders and policymakers.

There is a lack of studies that merit further attention such as the development of sustainability practices in management, and the role of global leadership for

sustainability (Fry and Egel, 2021; Liao, 2022; Gutterman, 2023). Also, we see cultural impacts and impacts upon policy, social cohesion, individual behavior, life paths of alumni (Findler *et al.*, 2019), empirical data for the impact of SDG4, graduate employment outcomes. In addition, we detected an impact in areas like industrial partnerships (Akdeniz, 2023), social equity (Contreras-Barraza *et al.*, 2021), quality assurance systems (Al-Bahi *et al.*, 2021; Janssens *et al.*, 2022), indicators and metrics (Fontdevila, 2023; Ydesen and Elfert, 2023) and contribution of world-class universities (Shu and Tian, 2024).

Our forward-thinking strategy will recommend the creation of a novel framework consisting of the context, requirements, recommendations, metrics and indicators behind each of the SDG4 targets. It can become a desirable solution in the direction of increasing theoretical and empirical studies of SDG4, and its relationship with other goals. In this way, goals and targets will be simplified for research.

This study presented a limited number of analyzed articles (journals). Due to the broad scope of existing papers, we had to exclude from the analysis the goals assessment, teaching and learning practices, metrics and indicators in a sustainability context of the SDG4. Therefore, future research needs to be inclined towards these clusters for research.

References

- Abdalla, S., Ramadan, E., Al-Belushi, M. A. K., and Al-Hooti, N. (2024), "Unveiling the Role of Arab Universities in Advancing Sustainable Development Goals: A Multi-Dimensional Analysis." *Sustainability* Vol. 16 No. 14. DOI:10.3390/su16145829.
- Abello-Romero, J., Mancilla, C., Sáez, W., Ganga-Contreras, F., and Durán-Seguel, I. (2023), "Sustainable Development and Corporate Sustainability of Chilean State Universities: Evidence from Their Strategic Elements." *Sustainability* 15 (14): 16. DOI:10.3390/su151411033.
- Acosta-Castellanos, P. M., and Queiruga-Dios, A. (2022), "Education for Sustainable Development (ESD): An Example of Curricular Inclusion in Environmental Engineering in Colombia." *Sustainability* Vol. 14 No.16. DOI:10.3390/su14169866.
- Akdeniz, E. (2023), "Toward a Sustainable Human Resources Management: Linking Green Human Resources Management Activities with ISO Standards." *SAGE Open* 1–28. DOI: 10.1177/21582440231192907.
- Al-Bahi, A.M., Abd-Elwahed, M.S., and Soliman, A.Y. (2021), "Implementation of Sustainability Indicators in Engineering Education Using a Combined Balanced Scorecard and Quality Function Deployment Approaches." *Sustainability* 13, 7083. DOI:10.3390/su13137083.
- Albareda-Tiana, S., García-González, E., Jiménez-Fontana, R., and Solís-Espallargas, C. (2019), "Implementing Pedagogical Approaches for ESD in Initial Teacher Training at Spanish Universities." *Sustainability* Vol. 11 No. 18. DOI: 10.3390/su11184927.
- Alfirević, N., Potočan, V., and Nedelko, Z. (2024), "Roles of Personal Values and Information Technology Usage in Forming the University Students' View of Environmental Sustainability: A Preliminary Regional

- Study of Economics and Business Students.” *Sustainability* Vol. 16 No. 22. DOI:10.3390/su16229830
- Alonso-García, S., Aznar-Díaz, I., Cáceres-Reche, M.-P., Trujillo-Torres, J.-M. and Romero-Rodríguez, J.-M. (2019), “Systematic Review of Good Teaching Practices with ICT in Spanish Higher Education. Trends and Challenges for Sustainability.” *Sustainability* Vol. 11 No. 24. DOI:10.3390/su11247150.
 - Amoozegar, A., Nguyen, L. B. D., Krishnasamy, H. N., Omanee, B., and Vasudevan, A. (2025), “Impact of University Reputation and Academic Quality on University Selection Among Vietnamese Postgraduate Students: A Moderation Analysis of Gender.” *Education Sciences* Vol. 15 No. 5. DOI:10.3390/educsci15050536.
 - Asadullah, M. N., Webb, A., and Islam, K. Md M. (2024), “SDG4mid-point challenge: Fixing the broken interlinkages between education and gender equality.” *International Journal of Educational Development* Vol. 106, No. 4. DOI: 10.1016/j.ijedudev.2024.103015.
 - Ashraf, M. W., and Alanezi, F. (2020), "Incorporation of Sustainability Concepts into the Engineering Core Program by Adopting a Micro Curriculum Approach: A Case Study in Saudi Arabia." *Sustainability* Vol. 12 No. 7. <https://doi.org/10.3390/su12072901>.
 - Balsalobre-Lorente, D., Nur, T., Topaloglu, E. E., and Pilar, L. (2024), “Do ICT and green technology matter in sustainable development goals?” *Sustainable Development* Vol. 33 No. 1. pp. 1545–1574. DOI:10.1002/sd.3185.
 - Bergman, Zinette, Bergman, M.M., Fernandes, K., Grossrieder, D., and Schneider, L. (2018), "The Contribution of UNESCO Chairs toward Achieving the UN Sustainable Development Goals." *Sustainability* Vol. 10 No. 12: 4471. DOI:10.3390/su10124471.
 - Bousdekis, A., Lepenioti, K., Apostolou, D., and Mentzas, G. (2022), “Data analytics in quality 4.0: literature review and future research directions.” *International Journal of Computer Integrated Manufacturing* DOI:10.1080/0951192X.2022.2128219.
 - Bucea-Manea-Tonis, R., Martins, O.M.D., Bucea-Manea-Tonis, R., Gheorghita, C., Kuleto, V., Ilic, M.P., and Simion, V.-E. (2021), “Blockchain Technology Enhances Sustainable Higher Education.” *Sustainability* Vol. 13 No. 22. DOI:10.3390/su132212347.
 - Cantó, José, Ull, M. À., Calero, M., Pina, T., Mayoral, O., and Vilches, A. (2025), “The 2030 Agenda and the SDGs in Initial Teacher Training: An Analysis of Teaching Guides.” *Sustainability* Vol. 17 No. 11. DOI:10.3390/su17114909.
 - Cesário, F., Sabino, A., Moreira, A., Portugal, M., and Correia, A. (2022), “Students’ Motivation for a Sustainable Career in the Hospitality Industry in Portugal.” *Sustainability* Vol. 14 No. 11. DOI:10.3390/su14116522.
 - Chaleta, Elisa, Saraiva, M., Leal, F., Fialho, I., and Borralho, A. (2021), "Higher Education and Sustainable Development Goals (SDG)—Potential Contribution of the Undergraduate Courses of the School of Social Sciences

- of the University of Évora." *Sustainability* 13 No. 4: 1828.
DOI:10.3390/su13041828.
- Chung, Fu-Ling, Chung, H.-H., and Lin, S.-M. (2024), "Current themes and future directions of sustainable development goals in higher education." *International Journal of Sustainability in Higher Education*, pp.1467-6370. DOI:10.1108/IJSHE-07-2023-0308.
 - Contreras-Barraza, N., Espinosa-Cristia, J. F., Salazar-Sepulveda, G., and Vega-Muñoz, A. (2021), "Entrepreneurial Intention: A Gender Study in Business and Economics Students from Chile." *Sustainability* Vol. 13, No. 9. DOI:10.3390/su13094693.
 - Cordaro, J. A., Murphy, C., and Redman, E. (2025), "Bridging STEM Education and Sustainability: Insights from Pennsylvania Educators." *Education Sciences* Vol. 15, No. 3. DOI:10.3390/educsci15030282.
 - De La Torre, E. M., Perez-Encinas, A., and Gomez-Mediavilla, G. (2022), "Fostering Sustainability through Mobility Knowledge, Skills, and Attitudes." *Sustainability* Vol. 14, No. 3. DOI:10.3390/su14031349.
 - Del Cerro Velázquez, F., and Méndez, G. M. (2018), "Augmented Reality and Mobile Devices: A Binominal Methodological Resource for Inclusive Education (SDG 4). An Example in Secondary Education." *Sustainability* Vol. 10, No. 10. DOI: 10.3390/su10103446.
 - Díaz-Lauzurica, B., and Moreno-Salinas, D. (2019), "Computational Thinking and Robotics: A Teaching Experience in Compulsory Secondary Education with Students with High Degree of Apathy and Demotivation." *Sustainability* Vol. 11 No. 18. DOI:10.3390/su11185109.
 - Duarte, M., Caeiro, S. S., Farinha, C. S., Moreira, A., Santos-Reis, M., Rigueiro, C., and Simão, J. (2023), "Integration of sustainability in the curricula of public higher education institutions in Portugal: do strategic plans and self-report align?" *International Journal of Sustainability in Higher Education* Vol. 24 No. 9, pp. 299-317. DOI 10.1108/IJSHE-01-2023-0001.
 - Escobar, C. A., McGovern, M. E., and Morales-Menendez, R. (2021), "Quality 4.0: a review of big data challenges in manufacturing.", *Journal of Intelligent Manufacturing* 32:2319–2334, <https://doi.org/10.1007/s10845-021-01765-4>.
 - Espada-Chavarria, R., Moreno-Rodriguez, R., and Jenaro, C. (2020), "Development of Vocational Maturity in University Students with Disabilities to Access, Obtain an Internship and Complete University Studies." *Education Sciences* Vol. 10 No. 12. DOI:10.3390/educsci10120386.
 - Fang, Xuening, Zhou, B., Tu, X., Ma, Q., and Wu, J. (2018), "What Kind of a Science is Sustainability Science? An Evidence-Based Reexamination." *Sustainability* Vol. 10, No. 5. DOI:10.3390/su10051478.
 - Ferreras-Garcia, R., Sales-Zaguirre, J., and Serradell-López, E. (2021), "Sustainable Innovation in Higher Education: The Impact of Gender on Innovation Competences." *Sustainability* Vol. 13 No. 9. DOI:10.3390/su13095004.

- Filho, W. L., Eustachio, J. H. P. P., 'Avila, L. V., Dinis, M. A. P., Hernandez-Diaz, P. M., Batista, K., Borsari, B., and Abubakar, I. R. (2025), "Enhancing the contribution of higher education institutions to sustainable development research: A focus on post-2015 SDGs." *Sustainable Development* 33:1745–1757. DOI: 10.1002/sd.3184.
- Findler, F., Schönherr, N., Lozano, R., Reider, D., and Martinuzzi, A. (2019). "The impacts of higher education institutions on sustainable development A review and conceptualization." *International Journal of Sustainability in Higher Education* Vol. 20 No. 1, 2019, pp. 23-38. DOI: 10.1108/IJSHE-07-2017-0114.
- Fontdevila, C. (2023), "The politics of good enough data. Developments, dilemmas and deadlocks in the production of global learning metrics." *International Journal of Educational Development* 96. DOI: 10.1016/j.ijedudev.2022.102684.
- Fry, L.W., and Egel, E. (2021), "Global Leadership for Sustainability." *Sustainability* 13, 6360. <https://doi.org/10.3390/su13116360>.
- Fuchs, P. G., Finatto, C. P., Birch, R. S., Dutra, A. R. de A., and Guerra, J. B. S. O. de A. (2023), "Sustainable Development Goals (SDGs) in Latin-American Universities." *Sustainability* Vol. 15 No. 11. DOI:10.3390/su15118556.
- García, G. E., Magaña, E. C., and Ariza, A. C. (2020), "Quality Education as a Sustainable Development Goal in the Context of 2030 Agenda: Bibliometric Approach." *Sustainability* Vol. 12 No. 15. DOI:10.3390/su12155884
- Ghosh, E., and Pearson, L. J. (2025), "Rethinking Economic Foundations for Sustainable Development: A Comprehensive Assessment of Six Economic Paradigms Against the SDGs." *Sustainability* Vol. 17, No. 10. DOI:10.3390/su17104567.
- Glavič, P. (2020), "Identifying Key Issues of Education for Sustainable Development." *Sustainability* Vol. 12 No. 16. DOI:10.3390/su12166500.
- Gómez-Llanos, E., and Durán-Barroso, P. (2020), "Learning Design Decisions in Massive Open Online Courses (MOOC) Applied to Higher Education in Civil-Engineering Topics." *Sustainability* Vol. 12 No. 20. DOI:10.3390/su12208430.
- Göçoglu, V. (2025), "Strategic intentions of higher education for sustainable development goals: Qualitative evidence from universities in Türkiye." *Sustainable Development* Vol. 33 No. 1. pp. 1575–1587. DOI:10.1002/sd.3186.
- Granados-Sánchez, J. (2022), "Levels of Transformation in Sustainable Curricula: The Case of Geography Education." *Sustainability* Vol. 14 No. 8. DOI:10.3390/su14084481.
- Greig, A., and Priddle, J. (2019), "Mapping Students' Development in Response to Sustainability Education: A Conceptual Model." *Sustainability* Vol. 11 No. 16. DOI: 10.3390/su11164324.
- Grigg, N. P. (2021), "Redefining quality in terms of value, risk and cost: a literature review." *International Journal of Quality & Reliability*

- Management* Vol. 38 No. 5, pp. 1065-1089. DOI 10.1108/IJQRM-06-2020-0209.
- Gutterman, A. S. (2023), "Sustainable Leadership." Available at SSRN: <https://ssrn.com/abstract=3833957> or <http://dx.doi.org/10.2139/ssrn.3833957>.
 - Hajdukiewicz, A., and Pera, B. (2020), "Education for Sustainable Development—The Case of Massive Open Online Courses." *Sustainability* Vol. 12 No. 20. DOI:10.3390/su12208542.
 - Husban, W. A. (2025), "The Impact of Integrating Sustainable Development Goals on Students' Awareness and Pro-Environmental Behavior: A Case Study of Jordan." *Sustainability* Vol. 17 No. 6. DOI:10.3390/su17062588.
 - Janssens, L., Kuppens, T., Mulà, I., Staniskiene, E., and Zimmermann, A. B. (2022), "Do European quality assurance frameworks support integration of transformative learning for sustainable development in higher education?" *International Journal of Sustainability in Higher Education* 23(8), 148-173. DOI 10.1108/IJSHE-07-2021-0273.
 - Kazazoglu, S. (2025), "Environmental Education Through Eco-Literacy: Integrating Sustainability into English Language Teaching." *Sustainability* Vol. 17 No. 5. DOI:10.3390/su17052156.
 - Kerras, H., Sánchez-Navarro, J. L., López-Becerra, E. I., and Gómez, M. D. de-M. (2020), "The Impact of the Gender Digital Divide on Sustainable Development: Comparative Analysis between the European Union and the Maghreb." *Sustainability* Vol. 12 No. 8. DOI:10.3390/su12083347.
 - Kioupi, Vasiliki, and Voulvoulis, N. (2019), "Education for Sustainable Development: A Systemic Framework for Connecting the SDGs to Educational Outcomes." *Sustainability*, Vol. 11 No. 21. DOI: 10.3390/su11216104.
 - Kohl, K., Hopkins, C., Barth, M., Michelsen, G., Dlouh, J., Razak, D. A., and Sanusi, Z. A. B. (2022), "A whole-institution approach towards sustainability: a crucial aspect of higher education's individual and collective engagement with the SDGs and beyond." *International Journal of Sustainability in Higher Education* Vol. 23 No. 2, pp. 218-236. DOI 10.1108/IJSHE-10-2020-0398.
 - Körfggen, Annemarie, Förster, K., Glatz, I., Maier, S., Becsi, B., Meyer, A., Kromp-Kolb, H., and Stötter, J. (2018), "It's a Hit! Mapping Austrian Research Contributions to the Sustainable Development Goals." *Sustainability* 10, no. 9: 3295. <https://doi.org/10.3390/su10093295>.
 - Kudo, Shogo, Mursaleen, H., Ness, B., and Nagao, M. (2018), "Exercise on Transdisciplinary: Lessons from a Field-Based Course on Rural Sustainability in an Aging Society." *Sustainability* Vol. 10 No. 4. DOI:10.3390/su10041155.
 - Kuusalu, S.-R., Laine, P., Maijala, M., Mutta, M., and Patzelt, M. (2024) "University language students' evaluations of ecological, social, cultural and economic sustainability and their importance in language teaching." *International Journal of Sustainability in Higher Education* Vol. 25 No. 9 pp. 1-18. DOI 10.1108/IJSHE-05-2023-0169.

- Lei, M., Alam, G. M., and bin Hassan, A. (2023), "Job Burnout amongst University Administrative Staff Members in China—A Perspective on Sustainable Development Goals (SDGs)." *Sustainability* Vol. 15 No. 11. DOI:10.3390/su15118873.
- Liao, Y. (2022), "Sustainable leadership: A literature review and prospects for future research." *Front. Psychol.* 13:1045570. DOI: 10.3389/fpsyg.2022.1045570.
- Liu, T., Zhu, X. and Cao, M. (2022), "Impacts of Reduced Inequalities on Quality Education: Examining the Relationship between Regional Sustainability and Higher Education." *Sustainability* Vol. 14 No. 21. DOI:10.3390/su142114112.
- Mair, S., and Druckman, A. (2023), "Assessing the suitability of sustainability frameworks for embedding sustainability in higher education curricula: pragmatism versus transformation." *International Journal of Sustainability in Higher Education* Vol. 24 No. 9, pp. 318-334. DOI 10.1108/IJSHE-08-2020-0315.
- Makrakis, V., Kostoulas-Makrakis, N., Siegmund, A., Martelletti, D.M., Álvarez-Vanegas, A., Castillo Ceja, M.A., Gonzalez, M., Carrillo Artavia, C., Jiménez-Elizondo, N., Velázquez Muñoz, D.E., Jimenez-Elizondo, A., and Larios, N. (2025), "Professionalization of Academic Teaching in Latin American Universities to Address SDGs Applying the Stages of Concern Theory." *Sustainability* Vol. 17, No. 13. DOI:10.3390/su17135850.
- Maldonado-Garcés, V., Sánchez-García, J. C., Hernández-Sánchez, B., Acosta-Vargas, P., and Araujo, E. (2025), "Physical Accessibility in Higher Education: Evaluating a University Campus in Ecuador for Sustainable Inclusion." *Sustainability* Vol. 17 No. 12. DOI:10.3390/su17125652.
- Marcos-Sánchez, R., Ferrández, D., and Morón, C. (2022), "Systems Thinking for Sustainability Education in Building and Business Administration and Management Degrees." *Sustainability* Vol. 14 No. 19. DOI:10.3390/su141911812.
- Matović, Stefana, Bajrami, D. D., Gajić, T., Lakic, M., Martinov, D., Šuput, S., Radosavac, A., and Đervida, R. (2024) "Beyond Numbers: Challenges in Measuring SDG 4Targets—Serbia's Perspective." *Sustainability* Vol. 16 No. 22. DOI:10.3390/su162210006.
- Mendonça, S., Piovesana, G. F., and Pissolito, V. (2025) "Geoethics and Sustainability: Addressing Challenges in Environmental Education for Achieving the SDGs." *Sustainability* Vol. 17 No. 2. DOI:10.3390/su17020574.
- Milkova, E., Moldoveanu, M., and Kreil, T. (2025), "Sustainable Education Through Information and Communication Technology: A Case Study on Enhancing Digital Competence and Academic Performance of Social Science Higher Education Students." *Sustainability* Vol. 17 No. 10. DOI:10.3390/su17104422.
- Miotto, G., López, M. P., and Rodríguez, J. R. (2019), "Gender Equality and UN Sustainable Development Goals: Priorities and Correlations in the Top

- Business Schools' Communication and Legitimation Strategies.” *Sustainability* Vol. 11 No. 2. DOI:10.3390/su11020302.
- Molina, J., Hai, N. V., Cheng, P.-H., and Chang, C.-Y. (2021), “SDG’s Quality Education Approach: Comparative Analysis of Natural Sciences Curriculum Guidelines between Taiwan and Colombia.” *Sustainability* Vol. 13 No. 6. DOI:10.3390/su13063352.
 - Momete, D.C., and Momete, M.M. (2021), “Map and Track the Performance in Education for Sustainable Development across the European Union.” *Sustainability*, 13, 13185. DOI:10.3390/su132313185.
 - Mróz, A., Ocetkiewicz, I., and Walotek-Ściańska, K. (2018), “Environmental Protection in School Curricula: Polish Context.” *Sustainability* 10, no. 12: 4558. DOI:10.3390/su10124558.
 - Muralidharan, K., Shanmugan, K., and Klochkov, Y. (2022) “The New Education Policy 2020, Digitalization and Quality of Life in India: Some Reflections.” *Education Sciences* Vol. 12 No. 2. DOI:10.3390/educsci12020075.
 - Nakidien, Toyer, Singh, M., and Sayed, Y. (2021), “Teachers and Teacher Education: Limitations and Possibilities of Attaining SDG4in South Africa.” *Education Sciences* Vol. 11 No. 2. DOI:10.3390/educsci11020066.
 - Nnam, I. J., Eneh, S. N., Ozoji, A. P., Nwekwo, M. N., Udefi, G. N., Okobo, M. M. and Chukwunwike, O. D. (2025), “Integrating Sustainability in Accounting Curricular of Higher Education Institutions: Analyzing Universities in an Emerging Economy.” *Sustainability* Vo. 17 No. 13. DOI:10.3390/su17135763.
 - Novy, J. W., Banerjee, B., and Matson, P. (2021), “A Core Curriculum for Sustainability Leadership.” *Sustainability* Vol. 13 No. 19. DOI:10.3390/su131910557.
 - Okanovic, A., Ješić, J., Đakovic, V., Vukadinovic, S., and Panic, A. A. (2021), “Increasing University Competitiveness through Assessment of Green Content in Curriculum and Eco-Labeling in Higher Education.” *Sustainability* 13, 712. <https://doi.org/10.3390/su13020712>.
 - Oketch, M. (2024) “SDG4targets: Neglected questions on conditions and circumstances for education reforms in Africa.” *International Journal of Educational Development* 106 pp. 199–233. DOI: 10.1016/j.ijedudev.2024.102999.
 - Okulich-Kazarin, V., Artyukhov, A., Skowron, Ł., Artyukhova, N., and Wołowicz, T. (2024), “Will AI Become a Threat to Higher Education Sustainability? A Study of Students’ Views.” *Sustainability* Vol. 16 No. 11. DOI:10.3390/su16114596.
 - Orozco-Messana, J., Martínez-Rubio, J. M., and González-Pons, A. M. (2020), “Sustainable Higher Education Development through Technology Enhanced Learning.” *Sustainability* Vol. 12 No. 9. DOI:10.3390/su12093600.
 - Pedraja-Rejas, L., Rodríguez-Ponce, E., Muñoz-Fritis, C., and Laroze, D. (2023), “Sustainable Development Goals and Education: A Bibliometric

- Review—The Case of Latin America.” *Sustainability* Vol. 15 No. 12. DOI:10.3390/su15129833.
- Petre, I. L., Hristache, D. A., Dobrescu, M. M., Constantin, A., Dumitra, E.-C., and Radu, C.-G. (2025), “Digital Communication in Higher Education Settings: A Pilot Study on Students’ Behavioural Trends.” *Sustainability* Vol. 17 No. 7. DOI:10.3390/su17073038.
 - Prieto-Jiménez, Esther, López-Catalán, L., López-Catalán, B., and Domínguez-Fernández, G. (2021), “Sustainable Development Goals and Education: A Bibliometric Mapping Analysis.” *Sustainability* Vol. 13 No. 4. DOI:10.3390/su13042126.
 - Ramos-Pla, Anabel, del Arco, I., Olondriz-Valverde, A., and Casol, L. F. (2025), “Education and Nursing in the 2030 Agenda: Challenges and Opportunities for University Education.” *Sustainability* Vol. 17, no. 6: 2757. <https://doi.org/10.3390/su17062757>.
 - Rangel-Pérez, C., Gato-Bermúdez, M.-J., Musicco-Nombela, D., and Ruiz-Alberdi, C. (2021), “The Massive Implementation of ICT in Universities and Its Implications for Ensuring SDG 4: Challenges and Difficulties for Professors.” *Sustainability* Vol. 13 No. 22. DOI:10.3390/su132212871.
 - Renta-Davids, A.-I., Camarero-Figuerola, M., and Tierno-García, J.-M. (2020), “Assessment of the Quality Education Awareness Competence of Pre-Service Educators Using Vignettes.” *Sustainability* Vol. 12 No. 23. DOI:10.3390/su122310203.
 - Rodríguez-Zurita, Denise, Jaya-Montalvo, M., Moreira-Arboleda, J., Raya-Díez, E., and Carrion-Mero, P. (2024), “Sustainable development through service learning and community engagement in higher education: a systematic literature review.” *International Journal of Sustainability in Higher Education* 1467-6370. DOI:10.1108/IJSHE-10-2023-0461.
 - Sadkowski, W. and Jedynak, P. (2022). *Quality Management and Accounting in Service Industries. A New Model of Quality Cost Calculation*. Published by Routledge.
 - Sarango-Lapo, C. P., Mena, J., and Ramírez-Montoya, M. S. (2021), “Evidence-Based Educational Innovation Model Linked to Digital Information Competence in the Framework of Education 4.0.” *Sustainability* Vol. 13 No. 18. DOI:10.3390/su131810034.
 - Sánchez-Carracedo, F., Moreno-Pino, F. M., Sureda, B., Antúnez, M., and Gutiérrez, I. (2019) “A Methodology to Analyze the Presence of Sustainability in Engineering Curricula. Case of Study: Ten Spanish Engineering Degree Curricula.” *Sustainability* Vol. 11 No.17. DOI:10.3390/su11174553.
 - Shu, J., and Tian, L. (2024), “Conceptualizing and comparing world-class universities’ contributions to global sustainability: Pathways, priorities and potential indicators.” *International Journal of Educational Development* 110. <https://doi.org/10.1016/j.ijedudev.2024.103138>.
 - Singh, A., Kanaujia, A., Singh, V. K., and Vinuesa, R. (2024), “Artificial intelligence for Sustainable Development Goals: Bibliometric patterns and

- concept evolution trajectories.” *Sustainable Development* Vol. 32 No. 1 pp. 724–754. DOI:10.1002/sd.2706.
- Son-Turan, S. (2022), “Fostering Equality in Education: The Blockchain Business Model for Higher Education (BBM-HE).” *Sustainability* Vol. 14 No. 5. DOI:10.3390/su14052955.
 - Sonetti, G., Barioglio, C., and Campobenedetto, D. (2020), “Education for Sustainability in Practice: A Review of Current Strategies within Italian Universities.” *Sustainability* Vol. 12, No. 13. DOI:10.3390/su12135246.
 - Sund, L., and Pashby, K. (2018), “Is It That We Do Not Want Them to Have Washing Machines?” *Ethical Global Issues Pedagogy in Swedish Classrooms.* *Sustainability* Vol. 10 No. 10. DOI:10.3390/su10103552.
 - Tafese M. B., and Kopp, E. (2025), “Education for sustainable development: analyzing research trends in higher education for sustainable development goals through bibliometric analysis.” *Discover Sustainability* Vol. 6 No. 51. DOI:10.1007/s43621-024-00711-7 6:51.
 - Tomov, M, & Velkoska, C., (2022), “Contribution of the quality costs to sustainable development.” *Production Engineering Archives* 28(2), 164-171. <http://doi.org/10.30657/pea.2022.28.19>.
 - Tosun, B, and Çetin F. (2025), “Mitigating Student Cynicism for Sustainable Academic Performance: University Identification and Academic Self-Efficacy.” *Sustainability* Vol. 17 No. 10. DOI: 10.3390/su17104263.
 - Tovar-Correal, M., and Pedraja-Rejas, L. (2025), “Gender, Ethnicity and Teaching Competencies: Do They Influence Intercultural Communicative Competence in Teacher Education?” *Education Sciences* Vol. 15 No. 5. DOI:10.3390/educsci15050520.
 - UNESCO, 2023 TIMES OF CRISIS, TIMES OF CHANGE Science for accelerating transformations to sustainable development.
 - Velkoska, C. (2021), “Sustainable quality – a challenge for gaining new knowledge for achieving a climate resilient future in the coming years.” *Vision International Scientific Journal* 6(2), pp. 69-89. DOI: <https://doi.org/10.55843/ivisum2126069v>.
 - Velkoska, C. (2024), “Sustainability and quality costs in the higher education institutions.” *Vision International Scientific Journal Special Edition* 67-95 <https://doi.org/10.55843/ivisum242067v>.
 - Velkoska, C. and Nuredin, M. (2023), “Quality assurance in the higher education in North Macedonia: challenges and key trends.” *Vision International Scientific Journal*, 8(1), 59-74, <https://doi.org/10.55843/ivisum2381059v>.
 - Velkoska, C., and Nuredin, A. (2024), “Internationalization from the perspective of quality assurance and enhancement: A comprehensive framework for internationalization through novel lens “Flow of Quality”.” *Journal of Higher Education Policy and Leadership Studies* 5(3), 88-111. <https://dx.doi.org/10.61186/johepal.5.3.88>.
 - Veres, Cristina, Tănase, M., Bacos, I. B., and Kardos, M. (2025), “Sustainable Universities: A Bibliometric and Thematic Analysis in Higher Education.” *Sustainability* Vol. 17 No. 5. DOI:10.3390/su17051817.

- Ydesen, C., and Elfert, M. (2023), “SDG4 as a global governance tool and the quest for recognizing diversity – Implications emerging from the intersections between inclusive education and assessment.” *International Journal of Educational Development* 103. DOI: 10.1016/j.ijedudev.2023.102932
- Zen, S., Ropo, E., Sovia, S., and Sansrisna (2024), “Teacher Identity and Climate Change Education: Implications for Curriculum Integration in Indonesia.” *Journal of Teacher Education for Sustainability* Vol. 26 No. 2 pp. 74–104. DOI:10.2478/jtes-2024-0017.
- Zhao, Y., Gómez, M. C. S., Llorente, A. M. P., and Zhao, L. (2021), “Digital Competence in Higher Education: Students’ Perception and Personal Factors.” *Sustainability* Vol. 13 No. 21. DOI:10.3390/su132112184.
- Zwolińska, K., Lorenc, S., and Pomykała, R. (2022) “Sustainable Development in Education from Students’ Perspective—Implementation of Sustainable Development in Curricula.” *Sustainability* Vol. 14 No. 6. DOI:10.3390/su14063398.
- Žalėniene, Inga and Pereira, P. (2021), “Higher Education for Sustainability: A Global Perspective.” *Geography and Sustainability* 2 pp. 99–106. DOI: 10.1016/j.geosus.2021.05.001.