Efforts by Universities to Promote Sustainability Competence Over The Last Few Decades : A Systematic Literature Review

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Abstract: This study analyzes the efforts by universities to promote sustainability competence over the last few decades and it is anticipated that it will make a valuable contribution to the advancement of literacy studies about education for sustainable development (ESD). This study employed a systematic literature review (SLR) method adapted from the PRISMA model. Qualitative data collection techniques were employed, followed by thematic analysis for data interpretation. This SLR obtained several interesting findings. It was found that the theme of SC was first collected in the Scopus database in 2009, and the increasing SC-higher education occurred during and post-COVID-19 pandemic, namely from 2020 to 2023. Various efforts have been made by universities around the world to promote SC. Their focus is on strengthening SC to realize the ESD and achieve SDGs through strengthening active learning, strengthening students and teachers, and reformulating and adapting the curriculum. It was also found that the author's country of origin is still dominated by countries in the European region, namely Spain, Sweden, and England. This fact is also supported by the concern of funding sponsors from Europe in funding research and publications regarding sustainability competencies. Therefore, this theme needs to campaign widely on other continents, especially Asia, Africa, Oceania, and America because its role and position are also important for sustainability.


Introduction
Sustainability competence (SC) relates to integrated knowledge, skills, attitudes and values; as an effort to empower every individual to take an effective role in facing the challenges and opportunities of world sustainability (Bianchi, 2020). The SC is crucial in higher education, notably during the industrial revolution. It encompasses systems, future, and value thinking, collaboration, and action-oriented skills. Bridging the gap between students' aspirations and the actual integration of SC in their education is essential amidst digital advancements (Scalabrino, 2022). Overall, SC is essential to ensure environmental, social, and economic sustainability; which means anticipating various challenges and problems that accompany it (Lenhart & Bouwma-Gearhart, 2022).

The campaign regarding the urgency of SC began to be promoted in the world of higher education along with the implementation of education for sustainable development. Researchers and observers in higher education have begun to take an interest in this topic in the last three decades. Mainstreaming SC in higher education is very urgent, considering the need to promote education for sustainable development (ESD) and sustainable development goals (SDGs) (Lambrechts et al., 2017). In this regard, based on the results of a search on the Scopus database carried out in April 2024, it was found that there were 146 publications on
the theme of SC in the last 30 years or 2009-2024 (out of a total of 766 for the all-fields category). Referring to this data, the new SC theme was first documented in the Scopus database in 2009, related to the topic of bachelor engineering education competencies at three European universities (Segalàs et al., 2009).

These publications need to be analyzed in depth to find interesting information, trends, and newest research. One of the most recommended techniques for study and analysis is a Systematic Literature Review (SLR). The SLR about SC is still very rare. The SLR focused on SC totaled seventh articles (by searching using "sustainability competence" AND review" in the Scopus database). SLR relates to an assessment of key SC (Annelin & Boström, 2022), human competencies (Galleli et al., 2020), and the urgency of green skills and SC (Montanari et al., 2023). So far, only two SLR-based articles have been found that are related to higher education, i.e. about service-learning as a niche innovation for sustainability (A Álvarez-Vanegas et al., 2024) and connecting competencies and pedagogical approaches (Lozano et al., 2017). Thus, it can be said that no SLR has been found that focuses on SC and university.

This study aims to analyze the efforts by universities to promote sustainability competence over the last few decades and it is anticipated that it will make a valuable contribution to the advancement of literacy studies about ESD. The outcomes of the data extraction process regarding the extent of scholarly investigations on SC in academic institutions globally will offer insights into the existing level of emphasis and endorsement for these subjects. Consequently, this SLR introduces a unique perspective in the realm of scholarly inquiry centered around higher education.

Research Method

This investigation constitutes SLR, a methodological approach designed to systematically identify, assess, and analyze all pertinent research findings about specific research inquiries, topics, or areas of interest (Chigbu et al., 2023). Independent study, also known as individual study, constitutes a fundamental form of research, whereas a systematic review represents a secondary level of investigation. This study used a qualitative approach with a systematic literature review adopted from Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), in inclusion and exclusion refers to Page et al (2021), which consists of four stages, namely identification, screening, eligibility, and inclusion (Selcuk, 2019).

The research question was what are the publication trends and efforts by universities to promote sustainable competence over the last few decades? We use the words "sustainability competence" in the disbursement menu in the Scopus database. Data simulation used "Analyze search results" provided by Scopus. To enrich data and analysis, we exported the data in *CSV format (for visualizing data process with VOSviewer) and *RIS (for synchronized with Mendeley). The search yielded 146 articles, so they needed to be filtered (inclusion and exclusion) to focus the analysis. The sequence of inclusion and exclusion is shown in Figure 1.
Figure 1. PRISMA flow diagram

Figure 1 shows that in the initial search, we found a total of 146 articles. At the end of the PRISMA process, we got 36 final articles that were suitable, which means 19 articles were excluded. We conducted a content analysis in this SLR. Combining a SLR with content analysis in scientific research provides numerous advantages. It enables a thorough comprehension of the current knowledge base about a specific subject, as demonstrated in the examination of exchange rate misalignment and its prominent authors.

Results and Discussion

Document by year

Figure 2 shows the number of articles in the Scopus database, annually from 2009 to 2024. It can be seen that the trend of publications on SC and higher education tends to increase from 2020 to 2023. The issue of SC began to receive attention in 2009, although in aggregate it has become the focus since 2018. We can see that during the COVID-19 pandemic, SC as part of the SDGs issue received more attention than researchers in universities. And this trend will continue to increase until post-pandemic (2022-2023). We cannot yet conclude the data for 2024 considering that this data still reaches April 2024.

Research in higher education during and after the COVID-19 pandemic has highlighted the importance of SC themes (Salem et al., 2023). The pandemic has necessitated a transformation in higher education institutions towards sustainability, digitalization and resilience (Liu & Li, 2023). Various studies emphasize the need for integrating technology in ESD, with a focus on educators who are familiar with digital technologies (Shishakly et al., 2024). Various studies have successfully identified strategies for dealing with post-pandemic uncertainty, emphasizing resilience, change management, digital transformation, and curriculum change as key dimensions for sustainability in higher education (Qureshi et al., 2024). The evolving higher education landscape post-COVID-19 underscores the need for practice and SC to anticipate the various challenges that may occur in the future (Jacques et al., 2023).
Author’s country or territory and Funding Sponsor

The trend of author’s country or territory of research related to “sustainability competence and universities” themes are presented in Figure 3.

Based on Figure 3, it can be seen that there are 15 countries where the authors come from, dominated by countries on the European continent, namely Spain, Sweden, United Kingdom, Finland, Germany, Netherlands, Hungary, Italy, Belgium and Czech Republic. Meanwhile, the only other countries are Mexico (America), South Africa (Africa) and China (Asia). This fact is also supported by the concern of funding sponsors from Europe in funding research and publications regarding sustainability competence (see Figure 4). Thus, the theme of SC is still an issue that is the focus of European countries. This theme, therefore, needs to be campaigned widely on other continents, especially Asia, Africa, Oceania and America because its role and position are also important in terms of sustainability.
The concept of sustainability and the acquisition of sustainability competencies have emerged as a predominant focal point within European higher education institutions and European funding sponsors due to a myriad of contributing factors. Europe boasts a rich historical background concerning environmental preservation and sustainable growth, primarily steered by an acknowledgment of the finite nature of natural resources and the adverse ramifications of pollution and environmental deterioration (Aydin et al., 2023). The European Union has enforced robust regulations and endeavors aimed at fostering sustainable development, exemplified by initiatives like the Green Deal (Koundouri et al., 2024). Hence, European academic institutions are actively addressing these imperatives by enhancing sustainability-related academic programs and scholarly investigations, equipping forthcoming cohorts with the requisite comprehension and aptitudes to confront global predicaments.

**Conceptual and practical implications (based on research concern and keywords trend)**

We can formulate conceptual and practical implications based on research concerns and keyword trends, as presented in Table 1 and Figure 5. The trend of research concern or being promoted related to "sustainability competence and universities" themes is presented in Table 1. Table 1 shows that various efforts have been made by universities in the world to promote SC. Their focus is on strengthening SC to realize SD or SDGs through strengthening active teaching and learning, strengthening students and teachers, and reformulating and adapting the curriculum at the tertiary level. This is very much in line with the keyword trend resulting from simulations with VOSviewer, as presented in Figure 5. Figure 5 shows that the word/phrase Sustainable Development is related to sustainability competence, and higher education (as the dominant phrase). These phrases then branch out and are related to teaching, active learning, students, teachers, and curriculum

<table>
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<tr>
<th>No</th>
<th>Reference</th>
<th>Important aspects that are of concern/promoted</th>
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<tbody>
<tr>
<td>1</td>
<td>(Segalas et al., 2009)</td>
<td>This article aims to identify and promote research on essential sustainability skills for undergraduate engineering students at three technical institutions using European Higher Education Area descriptors.</td>
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<td>2</td>
<td>(Ull et al., 2014)</td>
<td>A study examined educators' perceptions on integrating sustainability concepts into courses, revealing their stance on fostering essential SC.</td>
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<td>3</td>
<td>(Besong &amp; Holland, 2015)</td>
<td>This article presents the Dispositions, Abilities, and Behaviours (DAB) framework, which shaped the development of an intervention in the years 2013-2014 aimed at assessing SC in graduating undergraduate students at a university establishment.</td>
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<td>4</td>
<td>(Gardiner &amp; Rieckmann, 2015)</td>
<td>The University of Vechta in Germany implemented a course, &quot;Sustainability and the Future,&quot; as part of action research on essential sustainability skills in higher education, using reflective journaling to explore competency acquisition.</td>
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<td>5</td>
<td>(Lambrechts et al., 2017)</td>
<td>The article examines professional development initiatives focused on sustainability at a higher education institution, offering insights on organizational change and enhancing these initiatives to better integrate sustainability skills.</td>
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<td>6</td>
<td>(Keeler et al., 2018)</td>
<td>This study analyzes five city-university collaborations in three countries, revealing that understanding motivations, sustainability measures, and skills in both city administration and universities aids in spreading sustainable solutions.</td>
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<td>7</td>
<td>(Zhou et al., 2019)</td>
<td>This paper introduces collaborative learning by teaching (CLBT), a learner-focused strategy. It investigates student attitudes towards CLBT through an empirical study at a Chinese state university.</td>
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<td>8</td>
<td>(Dlouhá et al., 2019)</td>
<td>The tool's examination of SC shows a transformation continuum from holistic reasoning to future focus and the synergy between individual and systemic competencies. The evaluated models balance both dimensions, especially socio-emotional competencies linked to envisioning and achieving sustainable transformation.</td>
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<td>9</td>
<td>(Rubio et al., 2019)</td>
<td>Primary findings reveal that humanities and engineering courses, along with degree projects, effectively foster comprehensive and introspective methodologies. However, environmental issues are lacking in Informatics Engineering, and ethical dilemmas are absent in Industrial Engineering curricula.</td>
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<td>10</td>
<td>(Shephard et al., 2019)</td>
<td>The study detailed in this article delves into the potential for misconstruction or misinterpretation of fundamental principles in these disciplines to impede advancements towards their goals.</td>
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This study aimed to examine how Romanian technical universities integrate sustainability skill courses into their engineering curricula. Results showed varied implementation across universities and even within faculties, suggesting a fragmented approach to sustainability education.

This study investigates the Engineers without Borders Design Summit’s impact on developing sustainability skills. It suggests that contextualization, like employing sustainability principles as constraints, engaging with sustainability-oriented mentors, and confronting unsustainable practices, enhances individual commitment to sustainability.

Higher education institutions (HEIs) in Sweden are mandated, in accordance with the provisions of the Higher Education Act, to advocate for sustainable development (SD). This empirical investigation stands out as an exceptional analysis encompassing all HEIs within a nation.

The findings demonstrate enhancements in the attainment of these skills, stemming not solely from self-assessment but also from the research approach undertaken within this novel endeavor. Similarly, these outcomes suggest the efficacy of the pedagogical recommendation as a potential educational approach for upholding the continuity of the science education curriculum.

While initially designed for the purpose of filtering multimedia materials within an educational setting, this tool (along with the indicators included) has the potential to be applied to the curation and organization of diverse resources and tasks, ultimately identifying those that enhance the development of scientific skills.

Based on the findings, the participants enrolled in the Bachelor’s program in Early Childhood Education exhibited a superior proficiency in e-sustainable competence, particularly in the areas of general skills and the economic aspect of digital sustainability.

The worldwide findings indicate a significant dearth of sustainability competencies within the field of Mathematics Education, with merely 25% presence, particularly noting that ethical competencies exhibit the lowest relative presence at 10%.

Researchers proposed definition for the sustainability transversal competence is: “The student possesses the knowledge, skills and attitudes necessary for the successful performance of the task and the resolution of problems related to the challenges and opportunities for sustainability in today’s world”.

Multilevel analyses revealed that, on an individual level, prerequisites of previous knowledge alongside characteristics related to ESD, such as students’ engagement in activities and overall understanding of sustainability, emerged as the most influential factors in their progress. Furthermore, distinctions specific to grades and academic tracks were noted.

Novel methodologies offered here can shift focus towards sustainable development, helping curriculum developers and policymakers assess labor market demands for sustainability-related skills. The outcomes could form the basis for developing training programs and teaching materials with clear learning objectives.

The findings indicate that despite the absence of statistically significant discrepancies in the pre-test and post-test measurements, there is a discernible inclination towards enhancing personal norms regarding sustainable development.

This study delves into the cognitive process of teacher candidates as they interpret sustainable development and the intersection between adopting ESD in their teaching practice and entrepreneurial endeavors. The findings suggest that there is potential for profound learning experiences.

Researchers demonstrate the utilization of the evaluation instrument in a case study conducted at a University, and we formulate deductions regarding the insights it provides into how professionals in higher education can leverage its utilization.

The findings show that universal pedagogical approaches correlate with cultivating students’ sustainability mindset and engagement in sustainability actions. Moreover, enhancing students’ sustainability mindset directly influences their endorsement of the new environmental paradigm and pro-environmental behaviors.

The document provides results from a self-reflective practitioner-as-researcher action research carried out collaboratively by the educators of case studies.

This methodology for designing a curriculum has the potential to motivate other educational settings and scenarios in addressing the task of conceptualizing their pathway for developing sustainable competencies.

The study examines the importance of cultivating a sustainability competences paradigm through the promotion of sustainability education, utilization of pedagogical strategies, and enhancement of competences. It is essential to acknowledge and tackle the obstacles in order to prevent the emergence of a futile endeavor.

The integration of sustainability into educational frameworks, as elucidated through the
Barreiro-Gen, et al., (2022) incorporation of innovative practices, offers insight into the cultivation of competencies via pedagogical methodologies. The purpose of this study is to examine this phenomenon within the context of academic disciplines.

29 (Cano García & Lluch Molins, 2022) Higher educational institutions ought to advocate for the development of sustainability skills in their graduates as a result of its significance, a point that has been underscored amidst the pandemic. Nonetheless, there appears to be a waning emphasis on this aspect, evident in both the curriculum and the discourse among educators and students.

30 (Singh-Pillay, 2023) The results suggest that when pre-service technology teachers (PSTTs) are encouraged to engage actively in sustainability issues within their communities, they are more likely to make well-informed decisions regarding their future role as educators, the instructional methods they intend to utilize, and the types of knowledge they aim to cultivate in students.

31 (Lozano et al., 2023) Regression analysis identified Universal and Social categories as most effective for enhancing all competence groups. This led to the creation of the Sustainability Teaching System (STS), categorizing and illustrating pedagogical methods and sustainability competences for better comprehension.

32 (García-Alonso et al., 2023) This study examines the influence of a mathematics instructional scheme that enhances the creation of assignments on the subjects of mathematics and sustainability, particularly emphasizing ESD.

33 (Alejandro Álvarez-Vanegas et al., 2023) The results indicate that educators possess a certain level of understanding regarding ESD. Nevertheless, there exists a need for enhancement, especially concerning implementation. Furthermore, discrepancies emerge between the skills they strive to cultivate in their students and those they currently hold.

34 (Kadji-Beltrán, 2024) The results demonstrate that the participants exhibited a sense of confidence and effectiveness in delivering instruction on sustainability. They also enhanced their understanding of content, pedagogy, motivation, and willingness as a result of a profound sense of duty and accountability.

35 (Cuevas-Cancino et al., 2024) The researchers focus on three blended intensive programs in Finland and Hungary to study the impact of integrating project-based digital storytelling with reflective writing on students' sustainability competence during and after the pandemic.

36 (Vesala-Varttala et al., 2024) Traditional education falls short in tackling environmental challenges, necessitating scholars, institutions, and policymakers to establish and implement educational policies and strategies for a sustainable future for both humanity and the planet.

Figure 5. VOS-viewer display for type of analysis “Co-occurrence Keywords”

Sustainable development entails the overarching objective of attaining equilibrium among economic advancement, social fairness, and environmental safeguarding to fulfill current needs without jeopardizing the potential of forthcoming generations to fulfill their requirements (Zhao & Farriñas, 2023). Sustainability competence pertains to the knowledge, skills, and attitudes essential for individuals and entities to effectively contribute to
sustainable development (Laasch et al., 2023). The realm of higher education assumes a pivotal role in cultivating sustainability competence through the incorporation of sustainability tenets across various fields of study, provision of specialized educational programs, encouragement of research on sustainability dilemmas, and cultivation of principles related to environmental stewardship and societal accountability among both students and faculty members (Husamah et al., 2022). Using higher education, individuals can amass the requisite proficiencies to tackle intricate sustainability challenges and evolve into catalysts of constructive transformation within their communities and beyond (Žalėnienė & Pereira, 2021).

The correlation between active learning, students, teachers, and the curriculum is crucial for achieving sustainability. Active learning methods enable students to directly engage in their education, fostering a deeper understanding of sustainability issues. (Alam & Mohanty, 2023; Smeplass, 2023). Teachers assume a crucial role in establishing a conducive learning setting, fostering inclusive dialogues, and promoting cooperative learning approaches that empower students to connect sustainability principles with their encounters (Quintero-Angel et al., 2024). An integrated curriculum with sustainability principles ensures subjects aren't taught in isolation but are embedded within relevant contexts, reinforcing students' understanding of the interconnectedness of economic, social, and environmental aspects of sustainability. (Mondragon et al., 2023).

Conclusion
This review found that sustainability competence (SC) gained attention in the Scopus database from 2009, with a notable increase during and after the COVID-19 pandemic (2020-2023). Universities globally are enhancing SC through active learning, student-teacher empowerment, and curriculum adaptation. European countries, particularly Spain, Sweden, and England, lead in research, supported by European funding. The theme should be promoted more widely, especially in Asia, Africa, Oceania, and America, due to its vital role in sustainability.

Recommendation
We can provide recommendations that university leaders and higher education policy makers (government) are advised to strengthen SC through active integration into the curriculum and innovative learning methods/models. International collaboration and wider funding support, especially on the continents of Asia, Africa, Oceania, and America, need to be pursued by the relevant parties. This is important as a concrete effort to expand the reach and impact of SC and ESD implementation in achieving the SDGs.

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