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Bibliometric Analysis of Studies on Sustainability in Education

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Abstract

This research aimed to analyze the bibliometric properties of literature on sustainability within the educational sphere. Utilizing a descriptive survey approach alongside bibliometric analysis, the study evaluated this area's scholarly outputs and foundational dynamics. Data sourced from the Web of Science (WoS) database facilitated the examination of 1,587 articles on sustainability in education. Employing descriptive statistical methods, the study mapped out the thematic landscape of sustainability in education. It encompassed distribution assessments of scholarly works by geographical location, identified leading scholars, pivotal publications, and key journals, and conducted co-authorship evaluations to delineate the scholarly network. Moreover, analyses of trending topics and strategic diagrams, coupled with word cloud visualizations, were executed. The research unveiled those scholarly discussions on sustainability in education commenced in 1995, expanding over the ensuing three decades to encompass 1,587 articles authored by 4,169 contributors across 492 distinct outlets. The United States emerged as the foremost contributor to this body of research. Drawing on these insights, the study offered directions for future inquiries and practical applications in the field.

Keywords: Education, sustainability in education, bibliometric.

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Makale Türü	Başvuru Tarihi	Kabul Tarihi
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Öz

Araştırmanın amacı eğitimde sürdürülebilirlik kavramı hakkında yayımlanan çalışmaların bibliyometrik özellikleri açısından incelenmesidir. Araştırma betimsel tarama modelinde gerçekleştirilmiştir. Çalışmada yayın çıktılarını ve alanın temel yapısını incelemek için bibliyometrik yöntem kullanılmıştır. Web of Science (WoS) veri tabanında uzaktan eğitim ile ilgili veriler elde edilen veriler neticesinde 1587 çalışma analize tabi tutulmuştur. Araştırma kapsamında eğitimde sürdürülebilirlik kavramının tanımlayıcı yapısı için betimsel istatistiklerden, yayınların ülkelere göre dağılımını gösteren analizlerden, etkili yazarlar, makaleler ve dergilere ait betimsel istatistiklerden, uzaktan eğitim kavramı ile ilgili alanyazının sosyal yapısını ortaya koymaya yönelik ortak yazar analizlerinden, kavramsal yapıyı ortaya koymak amacıyla trend konu analizlerinden, stratejik diyagram ve kelime bulutu analizlerinden yararlanılmıştır. Araştırma sonucunda eğitimde sürdürülebilirlik ile ilgili ilk yayınların 1995 yılında literatüre girdiği, 1995-2023 yılları arasındaki otuz yıllık sürede "eğitimde sürdürülebilirlik" çalışmalarının 4169 yazar tarafından 1587 makalede ve 492 farklı kaynakta yayınlandığı bulgulanmıştır. Araştırma sonucunda eğitimde sürdürülebilirlik konusunda Amerika Birleşik Devletleri'nin en çok yayın yapan ülke olduğu sonucuna ulaşılmıştır. Araştırma kapsamında elde edilen veriler ışığında öneriler sunulmuştur.

Anahtar Sözcükler: Eğitim, eğitimde sürdürülebilirlik, bibliyometri.

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Introduction

In our contemporary era, the array of environmental, economic, societal, and cultural challenges we face increasingly underscores the criticality of the sustainability paradigm. Sustainability aims to satisfy the requirements of both current and upcoming generations by preserving natural assets, promoting economic growth, advancing social equity, and upholding cultural heterogeneity. Within this scope, the adoption and implementation of the sustainability ethos within educational realms hold marked importance (Ben-Eliyahu, 2015; Liasidou, 2015).

Sustainability pertains to the capacity of an endeavour, procedure, or framework to persist over time without exhausting available resources or compromising the well-being of future generations. This encompasses the judicious management of natural resources, engaging in economic endeavours that are benign to the environment, promoting social parity and justice, retaining cultural multiplicity, and upholding human dignity (Murray, 2012; Venkataraman, 2009).

Education is a fundamental pillar for sustainable growth, empowering individuals to expand their intellect, competencies, and ethical values. Sustainability involves instructing learners on environmental consciousness, fiscal accountability, social fairness, and cultural inclusivity within the educational sphere. Educational institutions must embrace methodologies grounded in the principles of environmental, economic, societal, and cultural sustainability, thereby empowering students to assimilate these tenets into their daily lives (Michelsen and Fischer, 2017). Education focused on sustainability ensures students gain scholarly insights and cultivate awareness and responsibility towards sustainability challenges. Such education provides opportunities for students to engage in eco-friendly behaviours, conserve natural resources, evolve sustainable consumption and production modalities, enhance their understanding of social justice and equity, and celebrate cultural variety. Moreover, sustainable education plays a pivotal role in refining students' analytical thinking, bolstering their capacity for problem-solving, and enhancing their communicative efficacy (Hopkins and McKeown, 2002; Kopnina, 2020; Nevin, 2008; Vare and Scott, 2008).

Sustainable education embodies an integrative approach spanning environmental, social, and economic spectrums. This method concentrates on ecological concerns and grapples with vital issues like social justice and economic progression. The multifaceted nature of sustainable education fosters cooperative endeavours aimed at safeguarding the future well-being of humanity and the planet. In this narrative, scholarly discourse delineates the principal facets of sustainable education, highlighting its expansive and interrelated dimensions (Koehn and Uitto, 2014; McFarlane and Ogazon, 2011; Michelsen and Fischer, 2017; Seghezzo, 2009; Warren, Archambault, and Foley, 2014):

Environmental Aspect: The environmental aspect of sustainable education emphasizes the preservation of the ecosystem and the responsible management of resources. It aims to enlighten individuals about their influence on the environment and motivates them to mitigate these impacts. Principal goals involve nurturing awareness of the environment, advocating for the prudent use of resources, safeguarding biological diversity, and addressing climate change challenges.

Social Aspect: The social aspect of sustainable education examines the dynamics between individuals and within communities. It covers topics such as social equity, fairness, human rights, cultural heterogeneity, and communal responsibility. Its purpose is to guide individuals toward fostering equitable and inclusive communities. In this domain, sustainable education aims to heighten sensitivity to societal issues, cultivate empathy and collaboration, champion social fairness, and encourage proactive engagement in civic life.

Economic Aspect: The economic aspect of sustainable education delves into economic growth and affluence sustainability. It scrutinises how economic activities consume resources, influence disparities in wealth, and affect the well-being of societies. Key ambitions include promoting the fair allocation of resources, advocating for sustainable production and consumption practices, aiding the shift towards an eco-friendly economy, and harmonising the environmental and societal repercussions of economic activities.

Cultural Aspect: The cultural aspect of sustainable education focuses on maintaining and transmitting cultural heritage and identities. It highlights the importance of cultural variety and

advocates for integrating diverse cultural viewpoints. The objective is to enable individuals to appreciate and understand various cultural backgrounds, honour cultural diversity, and benefit from intercultural exchanges. Sustainable education in this sphere involves enhancing awareness of cultural diversity, encouraging cultural dialogue, and efforts towards the conservation of cultural legacies.

Political Aspect: The political aspect of sustainable education underlines the importance of engaging in political processes and upholding democratic principles. It concerns itself with reinforcing democratic structures, advocating for equitable and transparent governance, and safeguarding the political rights of citizens. This dimension aims to foster political consciousness, reinforce dedication to democratic ideals, and inspire active participation in political affairs. In this framework, sustainable education encompasses education in democratic citizenship, education on human rights, and education for peace. Global Perspective: The global aspect of sustainable education advocates for cross-border collaboration to tackle worldwide challenges. This aspect involves addressing global environmental crises, developmental dilemmas, breaches of human rights, and intercultural disputes. The aim is to cultivate a sense of global citizenship, enhance awareness of international issues, and foster a global sense of responsibility. In this realm, sustainable education encompasses teachings on global citizenship, broadening comprehension of international predicaments, and fostering avenues for global collaboration.

Technological Insight: The technological facet of sustainable education delves into the application of technology through a sustainability lens. It covers areas such as sustainable energy sources, efficiency in energy use, environmental surveillance, eco-friendly technologies, and responsible digital engagement. The objective is to enlighten individuals on leveraging technology for sustainable progress while evaluating technological advancements' ecological and societal repercussions. Sustainable education in this domain promotes the integration of ICT in learning, the development of digital literacy, and the democratization of technology access.

Ecological Awareness: The ecological component of sustainable education champions living in sync with our natural surroundings. It emphasises understanding ecosystem dynamics, preserving biological diversity, maintaining ecological equilibrium, and valuing ecosystem services. The goal is to cultivate respect for nature, advocate for the prudent use of natural resources, and endorse ecologically balanced lifestyles. This approach to sustainable education focuses on heightening environmental consciousness, undertaking assessments of environmental impacts, and encouraging practices that align with natural principles.

Global Justice Insight: The dimension of global justice within sustainable education examines the pathways to achieving fairness and equality across the globe. It addresses equitable resource distribution worldwide, upholding the development rights of all communities, safeguarding human rights, and pursuing global economic and social equity. The ambition is to enlighten individuals about international injustices, champion global equity, and stimulate worldwide actions towards justice and equality. Sustainable education here involves teachings on global citizenship, deepening the understanding of international issues, and generating momentum for global advocacy and action.

Political Ecology Perspective: The political ecology angle of sustainable education explores the coexistence of human societies and the natural world. It stresses the importance of considering political, economic, and social dynamics in environmental decision-making. The intention is to render human-nature relationships more sustainable, address environmental challenges within a broader societal and political framework, and involve individuals in shaping environmental policies. In this context, sustainable education focuses on fostering political engagement, fighting for environmental justice, and crafting sustainable governance models.

The imperatives of sustainability and sustainable education are pivotal global necessities in our era. Incorporating sustainability principles within educational frameworks marks an essential move toward ensuring a habitable planet for future progenies. In light of this, there is a pressing need to propagate sustainable education practices and equip students with the knowledge, competencies, and ethos pertinent to sustainability. This study has been initiated to acknowledge the significance of assessing sustainability-related outputs in education and the foundational architecture of this domain. It

delves into the connections comprehensively, drawing on an extensive array of documents from global scholarly sources. The study aims to answer the following inquiries the following questions:

1. What is the descriptive structure of sustainability in education literature?
2. Who are the most influential authors, journals, and articles in sustainability in education literature?
3. What is the social structure of sustainability in education literature?
4. What is the conceptual structure of sustainability in education literature?

Method

In this study, bibliometric techniques were utilized to analyze the scholarly outputs concerning sustainability in education, alongside the core conceptual framework of the field. Bibliometrics, a statistical method, facilitates the assessment of research performance through the analysis of publications and citations, thereby uncovering the intellectual, social, and conceptual frameworks within a particular research domain (Aria & Cuccurullo, 2017; Cobo, López-Herrera, Herrera-Viedma & Herrera, 2011). Contrary to conventional literature reviews that delve into detailed analysis, bibliometric analysis provides a broad overview, enabling a comprehensive view of the collective trends and overarching themes in the research landscape (Zupic & Čater, 2015).

Data Sources

In this study, the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (Moher et al., 2009) guided the identification of resources related to sustainability in education. The initial step involved deciding on the database where resources on this topic would be searched. The Web of Science (WoS) is one of the world's oldest and most widely used databases. Updated daily, WoS hosts over 171 million sources, including articles, proceedings, abstracts, biographies, and more (Birkle, Pendlebury, Schnell & Adams, 2020). Due to WoS being the most frequently used database for bibliometric studies and containing the most influential journals and publications in the field, it was decided to conduct the searches in this database (Hu, Wang Ni, & Liu, 2020). In the WoS database, specific search strategies were developed to create a comprehensive database related to sustainability in education. Initially, more than ten studies on sustainability in education from Google Scholar and the WoS database were reviewed to determine keywords. While identifying these keywords, the plus (+) keywords feature in WoS was also utilized. In the second stage, trials were conducted to create the most suitable keyword index in the WoS database using the identified keywords. In the end, a search conducted on February 5, 2024, without any restrictions using the determined keyword index, resulted in a total of 2035 documents. The Web of Science (WoS) database offers filtering options during or after the search based on researchers' preferences. Initially, no filtering was applied to the accessed 2035 documents. However, filtering options were utilized to identify sources directly related to sustainability in education. Applying filters for "Article" as the document type, "SCI-EXPANDED, SSCI, ESCI" as the indexes, and "English" as the publication language resulted in a total of 1682 documents. The titles and abstracts of the studies accessed by two of the researchers were individually reviewed, and 95 documents that were not relevant were excluded. Finally, a plain text file containing data from 1587 articles published between 1995 and 2023, which were included in the study, was downloaded from the WoS database and uploaded to bibliometric analysis programs.

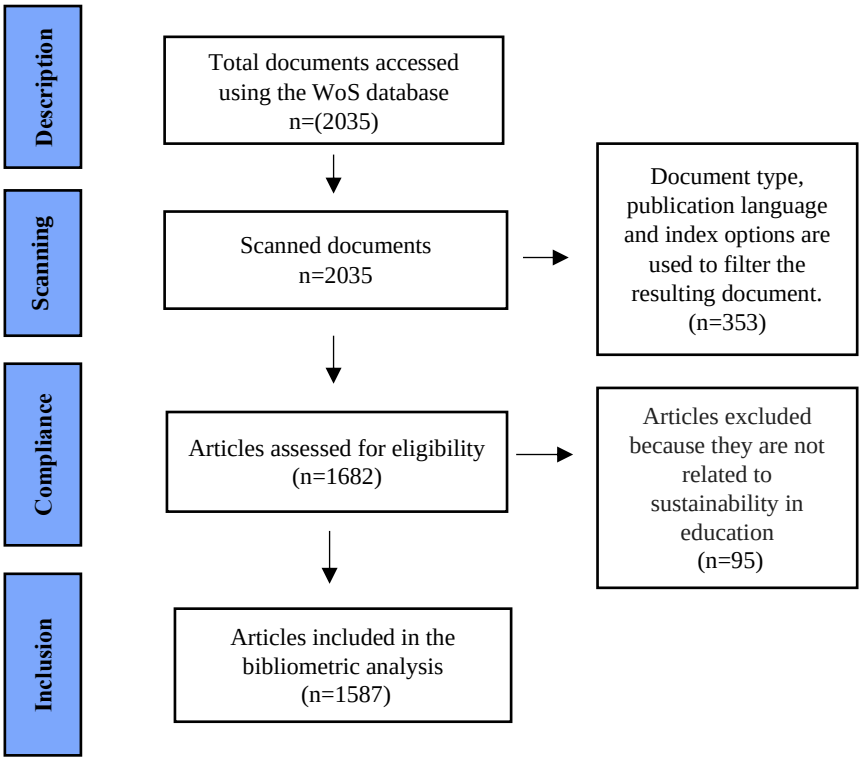


Figure 1. *PRISMA Flow Diagram of the Article Inclusion Process for the Study*

Data Analysis

This study applied bibliometric techniques to scrutinize the corpus of literature on sustainability within education. For the analytical process, both the open-source R package bibliometrix and the VOSviewer software were used. The bibliometrix tool, introduced by Aria & Cuccurullo (2017), is designed for performance evaluation and scientific mapping. Additionally, the Biblioshiny application, offering a user-friendly graphical interface for bibliometric, was employed in the analysis. This R package is compatible with datasets from the Web of Science (WoS), and for this study, metadata from 1587 articles retrieved from the WoS database was processed in plain text format through bibliometric.

The analysis was structured around specific research questions. Techniques such as descriptive statistics and the creation of visualization maps were used to depict the literature's geographic distribution regarding sustainability in education. Analysis of citations and additional descriptive metrics were pivotal in pinpointing key authors, influential publications, and leading journals within this academic sphere. Through the lens of co-citation, co-authorship, and co-word analysis, the study unveiled the intellectual, communal, and conceptual frameworks characterising the sustainability in education literature.

Co-citation analysis delves into the clustering of publications that constitute the intellectual bedrock of the field, frequently cited together in various studies. This analysis can focus on different units, such as studies, journals, or authors. Co-authorship analysis explores the collaborative networks among researchers, identifying connections between authors, countries, and institutions to map out the collaborative landscape. Finally, co-word analysis aims to discern prevailing research themes and establish a conceptual framework, illustrating the interrelations among these themes based on the terminology employed in titles, abstracts, or keywords.

Findings

The research findings are presented under the headings of general findings, the descriptive structure of sustainability in education literature, influential authors, articles, and journals, the

intellectual structure of sustainability in education literature, and current focus topics within sustainability in education literature.

Overview of Literature on Sustainability in Education

The general findings from the bibliometric analysis conducted on sustainability in education between 1995-2023 are shown in Table 1.

Table 1

General Information on Literature Related to Sustainability in Education

Total number of journals published	492
Total number of articles published	1587
Total number of authors published	4169
Number of single-author studies	307
Average citations per article	6,04

An examination of Table 1 reveals that the first publications featuring the concept of sustainability in education entered the literature in 1995. Over the thirty years from 1995 to 2023, studies on sustainability in education have been published by 4169 authors in 1587 articles across 492 different sources. The average citation rate of 6.04 per article confirms the high quality of articles produced in this field.

The distribution of research conducted between 1995-2023 on the general descriptive structure of sustainability in education literature across the years is shown in Figure 2.

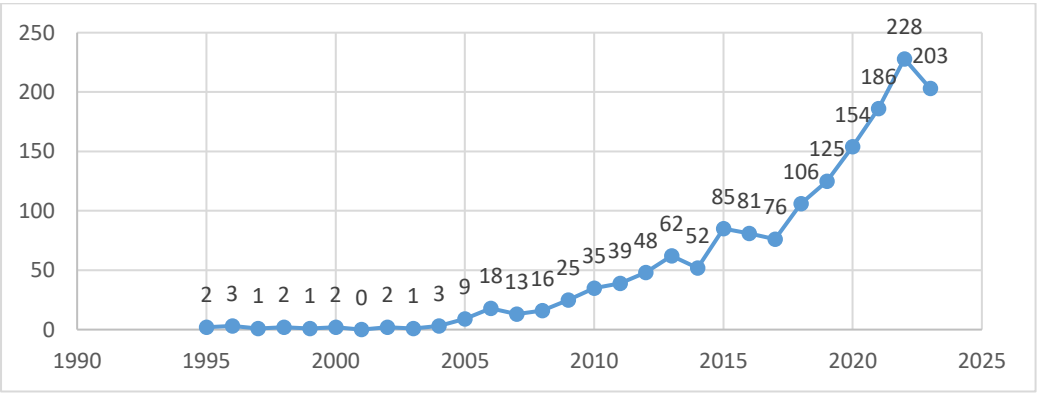


Figure 2. *Distribution of Publications Over the Years*

Analysing the dissemination of the 1,587 studies released from 1995 to 2023, it is observed that publications were sparse up to the 2000s. However, a marked escalation in research activity on sustainability within the educational sector began in 2010, evidenced by a significant uptick in publications. Despite periodic variances in annual publication rates, the trend underscores a sustained scholarly interest in this domain, peaking in 2022 with a record 228 articles. The spatial distribution of these articles related to sustainability in education across the specified period is depicted in Figure 3.

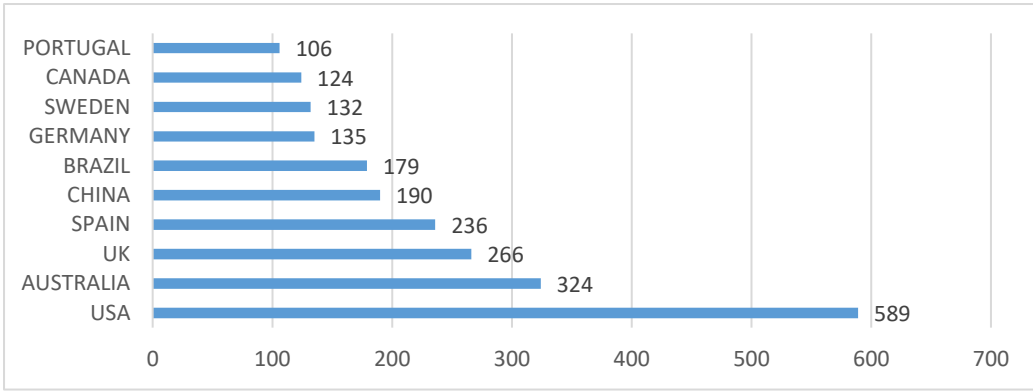


Figure 3. *Scientific Production by Countries*

Figure 3 illustrates the geographic spread of scholarly articles on sustainability in education, tracking the origin of this thematic focus in academic literature back to 1995. This overview considers the nations of the researchers cited within these articles. Leading the charge in terms of volume of contributions to sustainability in education are the United States, Australia, the United Kingdom, Spain, and China, with the United States standing out for its markedly superior publication output relative to the others.

An analysis of co-authorship across nations was conducted to map out the collaborative networks underpinning the sustainability in education discourse, serving as the primary lens for understanding the field's communal architecture. The insights drawn from this international co-authorship examination are presented in Figure 4.

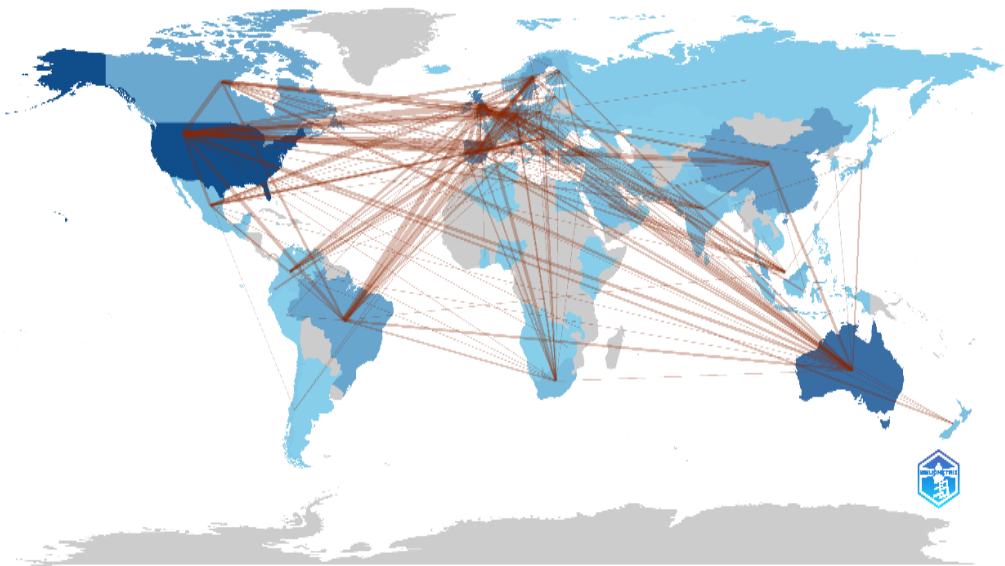


Figure 4. *Co-authorship Analysis (International)*

Analysis of the collaboration network depicted in Figure 4 reveals the United States as a pivotal contributor to sustainability in education research, exhibiting extensive collaborative ties with various nations. Additionally, countries like Australia, the United Kingdom, and Spain emerge as notable for their volume of research outputs and the breadth of their international collaborations compared to other countries.

The citation distribution across geographic regions for studies on sustainability in education spanning the years 1995 to 2023 is illustrated in Figure 5.

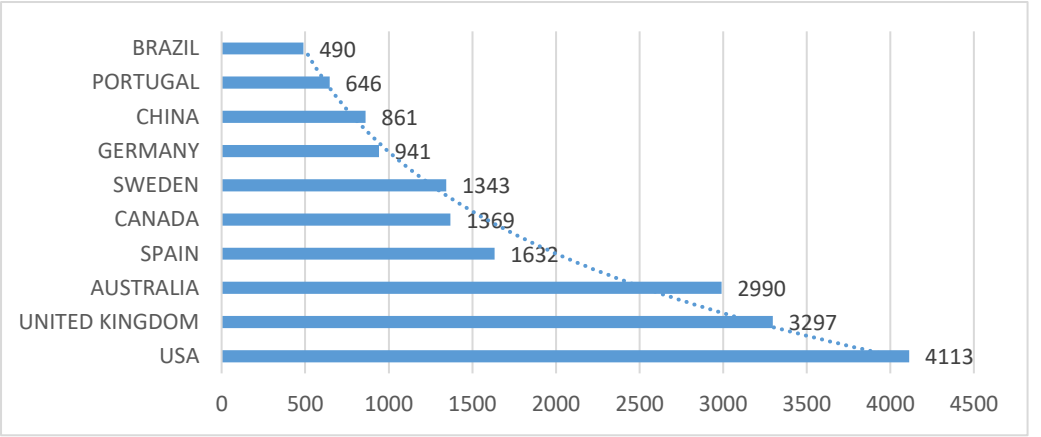


Figure 5. *Geographic Distribution of Citations*

An examination of Figure 5 reveals that research on sustainability in education is most frequently cited in the United States, with 4113 citations, followed by the United Kingdom, with 3297 citations, and Australia, with 2990 citations.

Influential Authors, Articles, and Journals in Sustainability in Education Literature

The articles included in the bibliometric analysis based on WoS data were examined regarding authors, publications, and citation counts. Figure 6 shows the most productive authors in the sustainability in education literature.

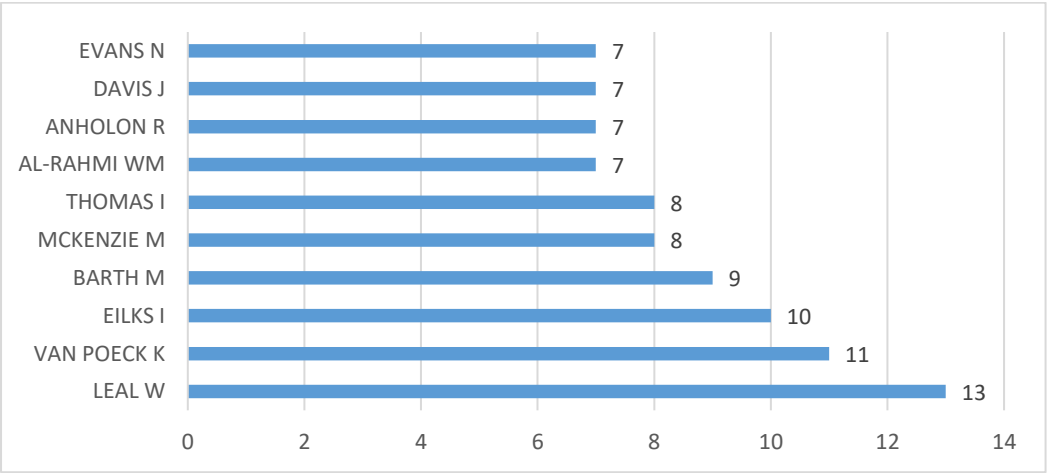


Figure 6. *Authors*

Figure 6 reveals that the authors with the highest contributions to sustainability in education literature, ranked by productivity, are Leal W., Van Poeck K., and Eilks I., respectively.

Investigations aimed at pinpointing seminal works within the sustainability in education body of literature have highlighted the articles with the most significant impact, as determined by local citation counts from 1998 to the current period, and these findings are cataloguedin Table 3.

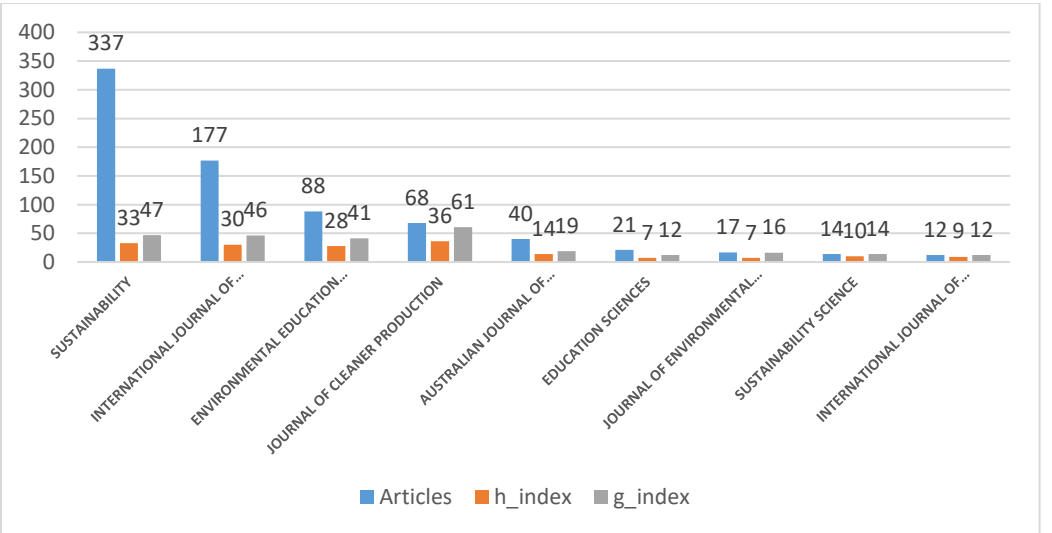
A review of Table 3 indicates that the article by Lozano, Lukman, Lozano, Huisingh, and Lambrechts (2013) stands out as the most pivotal in the sustainability in education, centring on a study concerning the sustainability within higher education.

Table 3. *Articles with the Most Local Citations*

Articles	Local Citation	Global Citation
Lozano, R., Lukman, R., Lozano, F. J., Huisingh, D., & Lambrechts, W. (2013). Declarations for sustainability in higher education: becoming better leaders, through addressing the university system. *Journal of Cleaner Production*, *48*, 10-19.	97	568
Sterling, S., & Thomas, I. (2006). Education for sustainability: the role of capabilities in guiding university curricula. *International Journal of Innovation and Sustainable Development*, *1*(4), 349-370.	38	135
Stephens, J. C., & Graham, A. C. (2010). Toward an empirical research agenda for sustainability in higher education: exploring the transition management framework. *Journal of Cleaner Production*, *18*(7), 611-618.	34	156
Aleixo, A. M., Leal, S., & Azeiteiro, U. M. (2018). Conceptualization of sustainable higher education institutions, roles, barriers, and challenges for sustainability: An exploratory study in Portugal. *Journal of Cleaner Production*, *172*, 1664-1673.	32	197
Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S., ... & Zint, M. (2021). Key competencies in sustainability in higher education—toward an agreed-upon reference framework. *Sustainability Science*, *16*, 13-29.	32	177

Efforts to determine the leading journals within the sustainability in education scholarly landscape have resulted in identifying the most influential publications on this subject, spanning from 1998 to the current time, as detailed in Table 4.

Table 4. *Journals*



An examination of Table 4 reveals that the journal publishing the most articles on sustainability in education is "*Sustainability*," while the journal with the highest h-index is "*Journal of Cleaner Production*." It is evident that the Sustainability journal, in particular, publishes research in the field of sustainability, thereby significantly contributing to the development of sustainability in education.

Conceptual Structure of Literature on Sustainability in Education from 1995-2023

Strategic diagrams are employed to illustrate trends associated with keywords in the realm of bibliometric studies. Such diagrams are segmented into four quadrants, each symbolizing distinct thematic categories. Centrality is plotted along the x-axis, while density appears on the y-axis. Motor themes, pivotal for the foundational structure of a research domain and exhibiting substantial development, are located in the top right quadrant. The top left quadrant houses isolated themes, the lower left quadrant encompasses fading themes, and the lower right quadrant identifies the core themes within the field. A thematic map covering research from 1995 to 2023 related to sustainability in education is depicted in Figure 7.

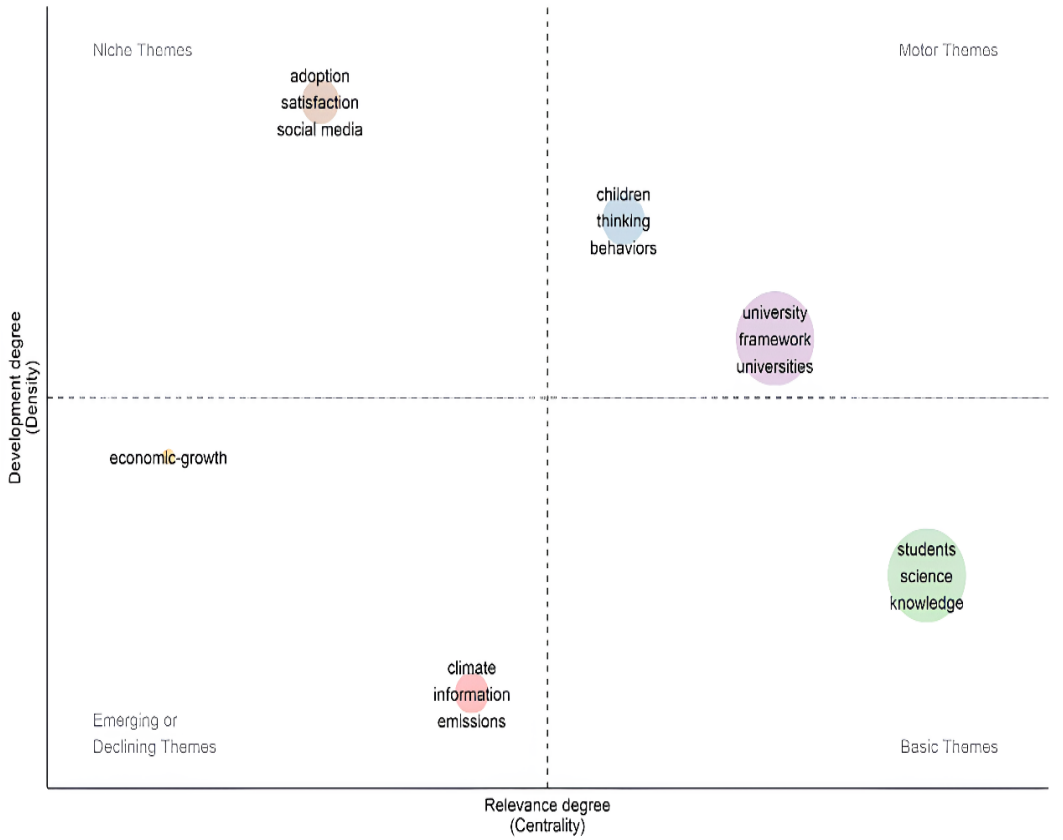


Figure 7. *Thematic Map of Research Published on Sustainability in Education Between 1995-2023*

As seen in Figure 7, the bottom right quadrant includes themes of students, science, and knowledge; the bottom left quadrant contains themes of climate, economic growth, emissions, and knowledge, indicating areas where sufficient research has not yet been conducted. In the top right quadrant, words like university, thinking, and behaviour are prominent, representing well-developed and essential themes for the field. The bottom left quadrant highlights themes losing interest and where the number of research publications is decreasing, with climate and knowledge themes standing out.

Recent trend topics related to sustainability in education are presented in Figure 8.

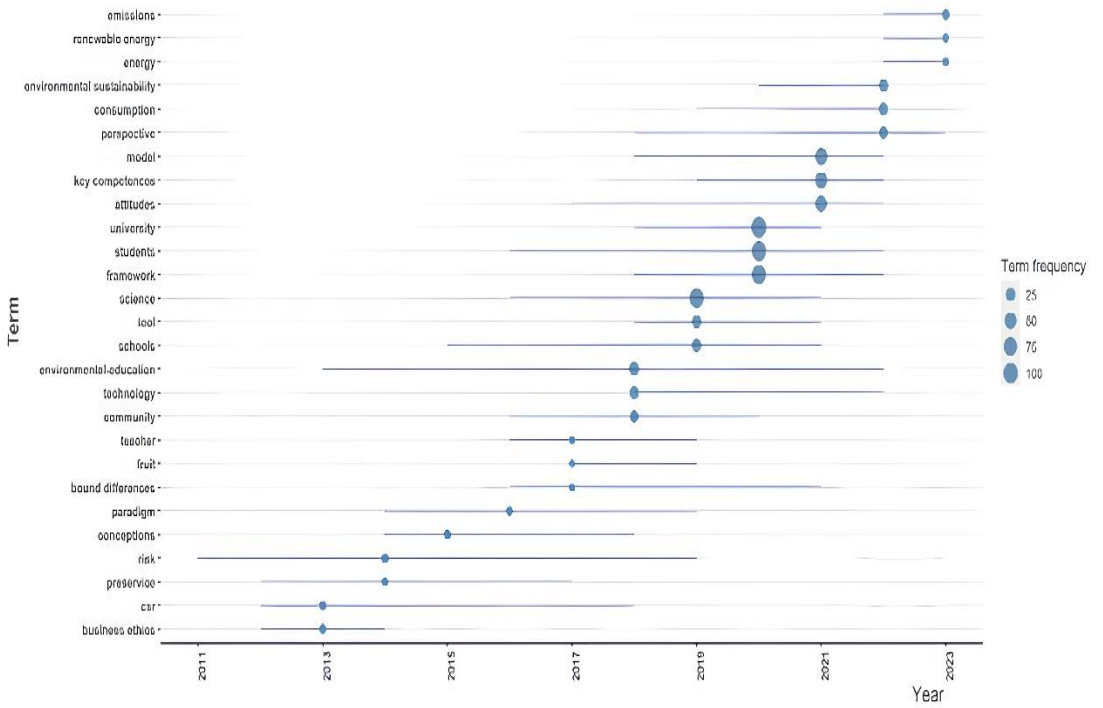


Figure 8. *Trend Topics Between 1995-2023*

The lines in Figure 8 represent the timeline placement of topics, while the nodes indicate the frequency of words. The length of the lines also shows that the topics are still of current interest. Examining Figure 8 reveals that there has been long-standing research in environmental education within the sustainability in education literature, which has remained relevant over time. Looking at recent trends, from 2022 onwards, energy and renewable energy topics have emerged as prominent.

Bibliometric analysis enables the visualization of keywords most commonly employed by authors in studies through a word cloud. Figure 9 displays the keywords that authors have most frequently utilized in their research on sustainability in education spanning the years 1995-2023.

Figure 9. *Word Cloud of Most Frequently Used Keywords in Research on Sustainability in Education Published Between 1995-2023*

An examination of Figure 8 shows that the most frequently used keywords are university (f= 105), students (f=87), science (f= 86), framework (f= 80), knowledge (f= 80).

Discussion, Conclusion and Recommendations

This study aims to illuminate in detail the evolutionary course of research related to sustainability in education (SE) and to present the developments in this field comprehensively. Covering 1587 articles between 1995 and 2023, this research examines the literature's size, development, and global distribution through bibliometric analysis. The analysis provides a broad perspective aimed at deciphering the countries where this field is studied, influential authors, significant articles, prominent journals, and the complex social networks of researchers. This discussion section seeks to delve deeper into the key findings that emerged during this comprehensive exploration process.

When evaluating the concrete findings of the study, it is essential to be aware of the contextual limitations and natural restrictions that shape the scope of the research. A primary limitation of the dataset used in this study is its focus mainly on journal articles, excluding other sources indexed in the WoS database. While the research offers valuable insight into the trajectory of journal articles, it does not aim to cover the entire contribution to the concept of sustainability in education. Secondly, the research faces a methodological limitation of bibliometric analysis; this method is a powerful but specific approach designed for reviewing and mapping the scientific landscape rather than synthesising various research findings. Moreover, bibliometric analysis is geared towards revealing trends in generating knowledge rather than amalgamating the outcomes of existing research. Consequently, this study does not supplant the necessity for detailed reviews that scrutinise the conclusions of works within this body of knowledge. Recognising these inherent limitations of the current research is crucial for accurately interpreting its results and situating them within a wider scholarly dialogue.

The research begins with a comprehensive overview of the descriptive structure of the sustainability in education (SE) literature. This overview encompasses the literature's size, development, annual variations, and geographical distribution, particularly highlighting a continuous growth in the sustainability in education literature since the 1990s. The study emphasizes how sustainability in education research has become more pronounced in practice since the 2010s. The developmental trend in SE literature revealed by the research findings aligns with the results of similar studies (Veiga Ávila et al., 2018; Hallinger & Chatpinyakoop, 2019; Yıldırım, 2020). Furthermore, recent years have seen increased research on sustainability in education. Longitudinal data indicate that 63% of SE literature was produced in the last five years since 2018. These trends confirm the rapidly growing interest in SE literature among academics. Another significant finding from this research is the concentration of the SE knowledge base within a group of economically developed Western societies, with a large portion (37%) originating from the USA. The findings demonstrate that while SE research is becoming a globally recognised and widespread field, most of this research comes from the USA. Consequently, we can infer that sustainability in education attracts attention primarily from researchers in more developed Western countries (USA, UK, Australia, Spain). Therefore, we believe there is a need to increase research in SE on a global scale and in developing countries.

This research, offering a detailed exploration of influential authors, articles, and journals in the SE literature, highlights significant contributions by key figures such as Leal W., Van Poeck K., and Eilks I. Undoubtedly, other researchers have also made substantial contributions to the field's development. For instance, academics like Wiek, Rieckmann, Huisingh, Lozano, Sterling, and Barth are emphasized for their significant contributions to developing sustainability literature in higher education (Hallinger & Chatpinyakoop, 2019). These researchers have significantly contributed to the field's development. Furthermore, we see that these authors produce the articles receiving the most citations, both locally and globally. Reviewing the academic recognition processes of SE research, this study notes that the journal "Sustainability" is the most published, while "Journal of Cleaner Production" holds the highest h-index, showcasing significant contributions to this field with national and international research. It can be said that "Sustainability" publishes research in the field of sustainability, thereby significantly contributing to the development of sustainability in education. The results of the journal analysis were generally consistent with the literature. For example, "Sustainability" (ranked 4th by Veiga Ávila et al., 3rd by Hallinger and Chatpinyakoop) and "Journal of Cleaner Production" (ranked 1st by Veiga Ávila et al., 2nd by Hallinger and Chatpinyakoop). Similarly, "International Journal of Sustainability in Higher Education," having the second-highest publications in this study, showed results consistent with other research (3rd by Veiga Ávila et al., 1st by Hallinger and Chatpinyakoop). These journals are

among the classic ones in sustainability management (Veiga Ávila et al., 2018). The consistency of results across these studies is more significant than the minor differences in journal rankings. Therefore, they represent the core journals publishing research related to SS, EER, JCP, JEE, AJEE, IJSHE, and HESD. All are high-quality journals, ranking high among WoS journals in their respective subject areas. A critical recommendation emerging from these findings is the increase in the number of journals that encourage and support research in the SE literature, which will provide a broader platform for international studies in the future

This study's third set of results revealed the prevailing themes currently under exploration within the SE body of literature. The analysis points out significant themes like university involvement, critical thinking, and behavioural studies as central to the discourse. These topics have been identified as well-established and vital to the academic field. The research underscores the ongoing relevance of these themes in scholarly debates. In line with this, research focusing on sustainability management in higher education settings, including aspects of teaching, learning, and capacity building in higher education for sustainable development (HESD), as well as research and development within HESD, aligns with existing literature findings (Hallinger & Chatpinyakoop, 2019). Furthermore, the emphasis on environmental education for sustainable development, education for development or global citizenship, and intercultural education (O'Flaherty & Liddy, 2018), along with inquiries into business, economics, environmental science, ecology, and management studies, are acknowledged as pertinent contemporary subjects (Veiga Ávila et al., 2018). This research similarly reveals that environmental education has been a long-standing focus and has remained on the agenda for an extended period. Meanwhile, themes such as climate and knowledge are beginning to lose their significance in the field over the years. A notable result is neglecting themes such as adoption, satisfaction, and social media in SE research. We believe that adoption should fundamentally underlie sustainability. As this research indicates, there is a need for studies in education that motivate society to embrace sustainable development. Looking at recent trends, the literature on SE shows that topics of energy and renewable energy are coming to the forefront. A significant development is that energy has become the most discussed topic among researchers in the SE field. We think one of the factors driving this focus on energy in SE research is the increasing interest in renewable energy sources for a sustainable environment. Our findings point to several conclusions. Firstly, the findings reveal that the capacity to conduct research related to sustainability in education (SE) is unevenly distributed worldwide, being more prevalent in Western developed countries. In contrast, comparatively fewer studies are conducted in developing societies. We emphasise the importance of encouraging academics in developing countries to engage in SE research. Secondly, this study compiled a rigorously validated inventory of pivotal journals, documents, and authors central to shaping discussions within this arena. The prominent scholars, texts, and periodicals highlighted in this analysis, which have played a significant role in advancing the discourse, serve as crucial reference points for scholars in Sustainability Education (SE), laying the groundwork for grasping key conceptual motifs and empirical insights. Given our planet's limited resources, there has been a discernible increase in the emphasis on sustainability over time. This trend is manifested in the expansion of SE literature, the diversity of contributing journals, and the calibre of journals and scholars engaging with this subject. Moreover, sustainability is increasingly as an imperative objective by governments, corporations, civil societies, and local governments at national and international gatherings, where diverse stakes frequently have a notable impact. Education is essential for fostering sustainable development and boosting individuals' capabilities to tackle environmental and developmental challenges. From this standpoint, educational initiatives should heighten community awareness regarding sustainability challenges and equip learners with the necessary knowledge and skills (Michelsen & Fischer, 2017). Reflecting on these insights, this research advocates for the inclusion of topics pertinent to embracing sustainable development within SE literature and urges a broadened scope to achieve a thorough and up-to-date comprehension of this critical field of study.

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