

Sustainability in Educational Research: Mapping the Field with a Bibliometric Analysis

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Abstract: This research uncovers contemporary patterns by employing the bibliometric analysis approach to analyze sustainability research in the education domain. Consequently, we map the academic outputs and observe a tendency of increased publications, which proves the growing interest in global sustainability imperatives with the help of WoS data. Regarding the publications, the United Kingdom, Germany, and the United States were the most productive, stressing an international focus and interdisciplinarity. The analysis showed that there was a shift in the topic focus from environmental education to sustainable education as a result of integrating SDGs into every level of education. As such, the results highlight the role of education in sustainability and necessitate more research for better evaluation and implementation of educational efforts. This study not only presents a history of the field but also sets a future agenda for the discipline, which is the significance of education for sustainability. In this way, our work enhances the knowledge of sustainability in education, and the results of our work lay a theoretical and methodological basis for further research and activities in the field.

Keywords: sustainability; educational research; bibliometric analysis; sustainable development



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1. Introduction

Our research aims to explore the intersection between education and sustainability. This study provides a comprehensive bibliometric analysis to understand how the concept of sustainable education has taken shape in the academic literature and how research trends, key players, and scholarly interactions in this field have evolved over time. As sustainability has become an inevitable necessity in today's world, the role of education in achieving this global goal has become even more important. Considering the power of education to transform societies and prepare future generations for a sustainable future, scientific analysis of this field is essential. This study aims to map the knowledge and academic dialogues in this field by examining academic studies on sustainable education in depth. For this purpose, bibliometric analysis techniques were applied to a large set of publications obtained from leading academic databases such as Web of Science (WoS). The analysis provides a structural view of sustainable education research, revealing relationships among years, publications, institutions, countries, and keywords. In this paper, key trends in the sustainable education literature, the most cited studies, and the influential authors and institutions are analyzed in detail. It also analyses the geographical distribution and evolution of research in this field over time, identifying current research gaps and potential future research directions. It is hoped that this study will serve as a valuable resource for researchers, policymakers, and practitioners working in the field of sustainable education and provide direction for future research in this area.

1.1. Sustainability and Education

Sustainability in education aims to develop an understanding of and commitment to sustainable development to support the environmental, economic, and social well-being of future generations. This process involves learning and teaching the principles of

sustainability and needs to be considered broadly, encompassing knowledge, skills, values, and behaviors. By combining environmental education (EE) and science education (FE), sustainability-related issues such as climate change, food scarcity, and biodiversity loss can be addressed. This integration has a significant impact on values, behaviors, and cognitive skills while encouraging individuals to engage in socioecological issues [1]. Sustainability embodies a mindset that emphasizes a respectful relationship with nature and goes beyond politics [2]. Higher education institutions in particular play a critical role in teaching sustainability by challenging prescriptive knowledge claims while engaging students in socio-scientific debates. This encourages a rethinking of university missions and transforms the educational process [3]. The essence of sustainability in education is to create a synergy between environmental awareness and scientific knowledge. This prepares individuals for responsible actions towards a sustainable future by promoting critical thinking and affective learning outcomes [4].

Introduced in 1987 with the Brundtland Report, the concept of sustainable development marks the emergence of sustainability in education. This report focuses on the tension between humanity's desire for life and the limits of nature. Over time, the concept of sustainability has been reinterpreted in its social, economic, and environmental dimensions [5]. This evolution has led to new debates on how to integrate and teach sustainability in education. The literature offers insights into the competencies required for sustainability [6], the evolution of the concept of sustainability in education [7], students' awareness of sustainability [8], and barriers in higher education [9]. Furthermore, the importance of addressing environmental, economic, and social dimensions in sustainability education is emphasized [10]. Sustainability in education requires reshaping teacher education programs and making teachers better equipped to address sustainability issues [11]. Educational institutions have an important role to play in promoting sustainability and environmental awareness. This is associated with increases in sustainability knowledge based on reflections of students' decision-making processes [12]. Sustainability in education offers the comprehensive changing focus of environmental education and the challenges and opportunities in promoting sustainability in educational settings. This emphasizes the importance of integrating sustainability principles into the education curriculum to promote environmental literacy and responsible citizenship.

1.2. Bibliometric Research about Sustainability

Hallinger and Nguyen conducted a comprehensive bibliometric review in 2020 and found that there had been an increase in publications on education for sustainable development (ESD) over the last three decades. This growth reflects the increasing importance of sustainability in educational research and practice. Their review showed that research on ESD is expanding beyond Anglo-American and European contexts towards greater geographical diversity [13]. Hallinger and Nguyen (2020) identified three dominant schools of thought within ESD, namely, "Education for Sustainable Development", "Developing a Sustainability Mindset", and "Teaching and Learning for Sustainability". This categorization helps to outline the contours of ESD research by highlighting various approaches to integrating sustainability into education [13]. In their study conducted in 2009–2018, Dođru et al. (2019) stated that in the bibliometric analysis of sustainable development studies in education, the United States of America (USA) played a key role in country collaborations, and the journal with the highest number of citations was the "*Journal of Cleaner Production*" [14]. Zhang and Wang (2022), in their research titled "Detecting the historical roots of education for sustainable development (ESD)", stated that among the 50 most cited references [15], Lozano and Wals contributed to the development of education for sustainable development research by publishing the most publications. "*The Journal of Cleaner Production*", "*International Journal of Sustainability in Higher Education*", and "*Environmental Education Research*" were the journals that published the most in the field of education for sustainable development [16]. Grosseck et al. (2019), who conducted a bibliometric review of research on education for sustainable development from 1992 to 2018,

emphasized that terms such as “sustainability education” could be used interchangeably and that there was a lack of comprehensive bibliometric analyses in this field [7]. Their study reported an increase in the number of publications, authors, and journals proving that ESD gained momentum during the examined study period. Similarly, the number of works written collaboratively by people (academics, researchers, etc.) from different parts and cultures of the world, especially from the USA and Europe, increased, which showed that publishing in ESD is the result of international efforts to bring this research field to the international arena. Their study identified two main research directions for the whole time span as follows: the integration of education into sustainable development and the integration of sustainable development into education. Machado and Davin (2023) analyzed studies on sustainability in higher education [17]. Bibliometric analysis was carried out using the Scopus database, which allowed the identification of 4410 publications involving elements of ‘higher education’ and ‘sustainability’. The authors concluded that the number of publications in this field has shown a significant increase in the last 30 years, with the United States, the United Kingdom, Spain, Australia, and Germany emerging as the countries with the most publications and Leuphana University Lüneburg, the Royal Melbourne Institute of Technology, Hamburg University of Applied Sciences, Manchester Metropolitan University, and Arizona State University being the academic institutions with the most publications in the field. Bibliometric analyses of sustainability in education shed light on the dynamic and complex nature of the field. They reveal a significant increase in research interest, a diverse intellectual landscape with different schools of thought, and an emphasis on affective learning and competence development. They also foreground the importance of innovative pedagogical frameworks and the interdisciplinary nature of sustainability research. For the future, further empirical research is needed to deepen our understanding of effective sustainability education practices and to support the integration of sustainability principles across all levels of education.

1.3. Importance of This Research

The significance of this research lies in its exploration of the intersection of education and sustainability and of how the concept of sustainable education has been shaped in the academic literature. Sustainability has become an inevitable necessity in today’s world, and the role of education in achieving that global goal needs to be understood and emphasised. Education has the power to transform societies and prepare future generations for a sustainable future, making scientific analyses in this field very important.

The aim of the present study is to map the body of knowledge and academic dialogues in this field by examining academic studies on sustainable education in depth. This is achieved by applying bibliometric analysis techniques to a large set of publications obtained from the Web of Science (WoS), a leading academic database. The analysis is intended to provide a structural overview of sustainable education research, revealing relationships among publication years, publications, institutions, countries, keywords, and concepts.

The sub-objectives of the research are as follows:

- To analyse in detail the publication years, publications, institutions, and keywords in the literature on sustainable education, and
- To analyse the geographical distribution and evolution of sustainability research over time.

2. Methods

Bibliometric analysis, which originated in the field of library and information science, has become a fundamental method for evaluating research output in various disciplines [18,19]. It includes quantitative analysis and statistics. It is widely used in library and information science to evaluate research performance and impact [19,20]. It helps to understand patterns of performance and impact by allowing evidence-based description, comparison, and visualization of research outputs [19,20]. It is used to examine scientific production, assess the impact of research, and evaluate the impact of authors in library

and information science research [21,22]. Furthermore, bibliometrics is essential for exploring issues in bibliometric research through citation networks and semantic analysis and provides information about the structure and impact of the academic literature [23].

Bibliometric analysis is a quantitative method that involves analyzing scientific publications, research, and other academic outputs using mathematical and statistical methods. Bibliometrics assesses the number of publications, citation rates, institutions, and journals and quantitatively analyses the amount of knowledge in a given research area, its growth rate, the most influential researchers and institutions, research networks and collaborations, the most cited works, and research trends. This analysis is used for various purposes in the fields of science and technology, in particular, for the evaluation of research performance and the study of scientific impact. Bibliometric indicators play an important role in measuring the scientific productivity and impact of researchers and organizations and are frequently used in areas such as funding decisions, appointments, and promotions [24]. This quantitative approach can help to explain patterns observed in literature sets and to identify previous, current, and future research trends.

2.1. Research Design

This research was conducted using quantitative data obtained from the Web of Science (WoS) database. This methodological approach enabled a comprehensive analysis of the field by combining numerical data analysis with the exploration of patterns and themes in the literature.

Bibliometric analysis is a popular and rigorous method for exploring and analyzing large volumes of scientific data. This method allows us to decipher the evolutionary nuances of a specific field and shed light on new areas emerging within it. Bibliometric analysis involves analyzing the quantitative and qualitative characteristics of scientific publications, institutions, and research fields using mathematical and statistical methods. Common bibliometric indicators include quantity indicators that measure the productivity of a particular researcher; quality indicators that measure the quality (or “performance”) of a researcher’s outputs; and structural indicators that measure the connections between publications and research fields [15,24]. Bibliometric analysis has become an increasingly important tool for research and development policymakers in decision-making processes. It is particularly recognized as part of the research evaluation methodology in science and applied fields. It is especially important for researchers and organizations, as these measurements are often used in funding decisions, appointments, and promotions of researchers. These methods help us objectively evaluate the performance and impact of research in a particular field, thereby providing information about the quality and impact of scientific publications.

2.2. Data Collection

In choosing Web of Science (WoS) over Scopus for bibliometric analysis, it was important to consider the features and coverage of both databases. While Scopus is known for its scope and user-friendly interface, Web of Science is known for its selective journal coverage and quality data [25,26]. The Web of Science Core Collection (WoSCC) is particularly emphasized because it contains meticulously curated, complete literature data, including titles, abstracts, keywords, references, and citations, making it a preferred choice for scientometric analyses [25]. Although Scopus is well aligned with Web of Science and shares common features such as coverage and indexing policies, Web of Science’s selective journal-based inclusion policies provide a more focused and quality-controlled dataset for bibliometric analysis [27]. Web of Science is established as an important bibliometric data source and its citation indexes are widely used for research evaluation [28]. The selective nature of Web of Science’s journal coverage, coupled with its quality-controlled data, makes it a reliable source for conducting responsible bibliometric analysis in the field of scientometrics [26]. As the Web of Science Core Collection is increasingly applied in academic research, this data source should be used with caution [29]. Therefore, users are advised to specify the

sub-datasets of the customized Web of Science Core Collection they used [30]. Even for some institutions that subscribe to all the expensive datasets of the Web of Science Core Collection, it is necessary to specify sub-datasets and coverage time periods, as the author institution's coverage information may not be transparent to others [30].

The data collection process of this study involved the systematic scanning of academic publications related to sustainability in education from 1998 to 2023. The search criteria included keywords and related terms such as “sustainability”, “education for sustainable development”, and “higher education”. The selection process was guided by relevance to the research question, the impact factor of the journals, and the citation count of the publications to ensure the inclusion of significant and influential studies. Subsequently, the “PRISMA 2020” protocol was followed (Figure 1). The PRISMA Checklist has been listed as Supplementary Materials.



Figure 1. PRISMA Protocol. * Book chapters, proceedings, and reviews were removed; ** ESCI, BKCI, SCI-EXP were REMOVED; *** ONLY OPEN-ACCESS SELECTED; **** YEAR 2024 ARTICLES were REMOVED.

We began our research with a broad dataset comprising 10,239 records obtained from various academic databases. However, a significant portion of these records were deemed unsuitable for the initial screening. At this stage, we excluded book chapters, conference papers, and review studies, choosing only journal articles due to their provision of more extensive and detailed information. This left us with 7470 records for closer examination. During the screening phase, we meticulously reviewed these records and excluded 4401 of them based on the predefined inclusion and exclusion criteria, including removing those indexed in the Emerging Sources Citation Index (ESCI), Book Citation Index (BKCI), and Science Citation Index-Expanded (SCI-EXP). The ESCI generally includes more recent or less established journals than those in the main indexes (i.e., the SCI and SSCI). By excluding ESCI entries, we aimed to focus on more established peer-reviewed literature with a higher level of academic rigour and impact. The BKCI includes book chapters and conference proceedings, which, while valuable, are generally not peer-reviewed to the

same extent as journal articles. By excluding the BKCI, we ensured a consistent focus on peer-reviewed journal articles. Furthermore, open access articles inherently have higher citation rates and greater dissemination than articles behind paywalls. By focusing on open access literature, we aimed to capture more widely read and cited research to provide a more comprehensive view of the development and impact of the field. Finally, the SCI-EXP was excluded to ensure that the included studies were of the highest quality and rigour. The SCI-EXP features a wider range of journals, which may include more recent or less established publications. Excluding those sources allowed us to focus on journals that are more likely to have higher levels of peer review and more established credibility. Furthermore, while the SSCI covers social sciences in education, journals indexed in the SCI-EXP cover interdisciplinary topics, often including natural sciences. Excluding those records helped us achieve a more comprehensive view of educational research.

We obtained reports on 3069 records in the next step of the analysis. Due to subscription paywalls or the unavailability of digital formats, we were unable to access 2179 of those publications. A suitability assessment, including a thorough examination of the methodologies used in the studies and their relevance to education sustainability, was carried out for the 890 accessible reports. We excluded studies that did not meet our criteria, including 11 reports from 2024 (as the year had not ended when the search was conducted). Thus, we identified 879 studies to be included in our final review. This final set of carefully selected studies from an original pool of more than 10,000 records provided a strong basis for our systematic review. They constitute the best scientific research currently available on the subject, being comprehensive, appropriate, and of high quality, thus ensuring the scope and credibility of our examination. The quantitative data from these publications were analyzed according to the number of citations, publication dates, and geographic distribution. Qualitative data were obtained from an analysis of the content of the chosen publications, focusing on the themes, concepts, and methodologies used in the field of education sustainability research.

2.3. Data Analysis

Quantitative data were analysed using VOSviewer, a tool for creating and visualising bibliometric networks. To identify the most influential countries and institutions, as well as key concepts and themes in this field, mapping was performed for networks of common authorship, citations, and keywords. VOSviewer's visual tools were used to evaluate relationships among those networks. The visualisations made it easier to understand relationships, groups, and key trends for the considered variables. Various aspects of the networks were highlighted using different colours, sizes, and labels to depict years. Institutions and countries were ranked based on their total link strength.

2.4. Ethical Considerations

All data used in this study were obtained from publicly available sources. The research adhered to ethical standards related to the use and citation of published works. Efforts were made to ensure the collected data's accuracy and maintain the confidentiality of unpublished works examined during the research process.

2.5. Limitations and Challenges

This study has inevitable limitations arising from the scope of the scanned database and the selection criteria, which may have influenced the findings. Furthermore, the rapidly evolving nature of sustainability in education means that new publications might not have been included in the analysis. Challenges encountered during the analysis process, such as variability in the terminology used to define sustainability in education, were addressed by using a broad set of search terms.

3. Results

Figure 2 has three sections, representing the introduction, development, and maturity phases.

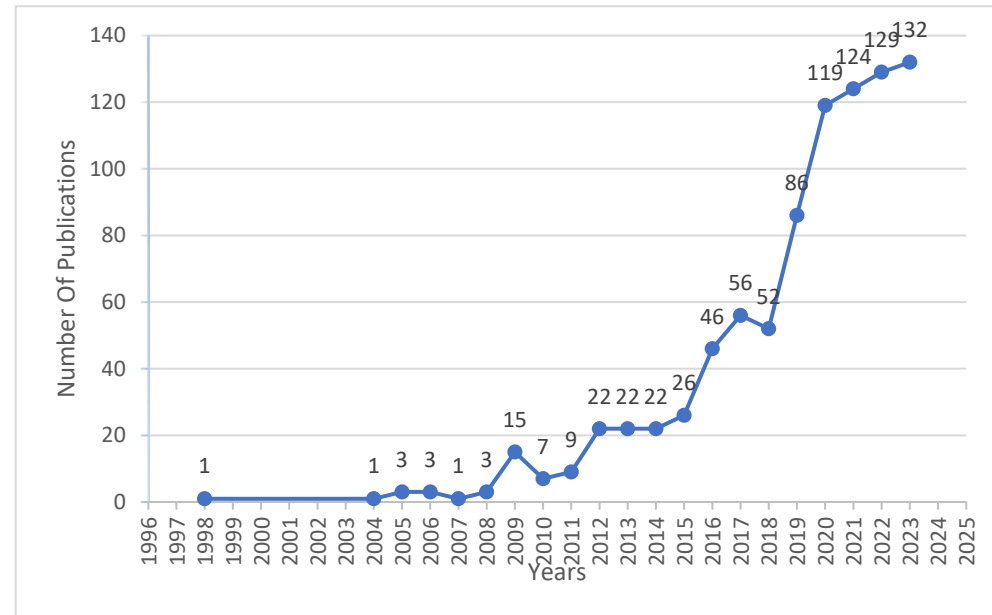


Figure 2. Number of publications.

The introduction phase was from 1996 to 2008. During this period, the number of publications was quite low and showed a steady increase. From 1996 to 2008, the annual number of publications typically varied between single digits and low double digits. This period indicates that the topic was new in academic circles and had not yet attracted widespread interest. The low publication numbers may suggest that awareness and motivation among researchers and educators regarding the importance of sustainability were still in their initial stages.

The development phase was from 2009 to 2017. Starting in 2009, there was a noticeable increase in the number of publications. During the period from 2009 to 2017, the numbers gradually increased each year, exceeding 50 throughout this phase. This phase can be interpreted as a period when the topic of sustainability gained more interest in educational sciences, becoming significant in research and practice. The global emphasis on sustainability and the introduction of the United Nations' Sustainable Development Goals (SDGs) in 2015 increased interest in sustainability-related research, including its integration into education. Improved funding opportunities and policy directives supporting sustainability education research are likely to have contributed to the increased output. The expansion of academic databases such as Web of Science (WoS) also played an important role during this period. These databases increased their coverage by indexing more journals and articles, thus capturing a wider scope of research output. This expansion in database coverage contributed to the significant growth in research output.

The maturity phase was from 2018 to 2023. From 2018 onwards, the increase in publication numbers gained momentum and continued with significant acceleration until 2023. The publication numbers reaching into the hundreds signify that this topic was fully integrated into the field of educational sciences and became a significant area of research. Sustainability became a mainstream topic in educational sciences with the widespread adoption of sustainability principles in educational policies, curricula, and teacher training programs. The interdisciplinary nature of sustainability research attracted scholars from various fields, further increasing the number of publications. The continued expansion and improvement of database indexing practices continued to generate more research

outputs. This included better indexing of interdisciplinary journals and greater inclusion of open-access articles, which further contributed to the observed growth.

Thus, the observed growth in research outputs is a combination of increased academic interest, policy support, and improved database coverage, which collectively highlight the growing importance and recognition of sustainability in education.

Figure 3 shows the cooperation among countries and the countries of origin of the publications related to the concept of sustainable education. The circles (points) on the map correspond to the countries and the links among them refer to collaborations existing among the countries. The size of the nodes represents the number of publications from a given country or the centrality of the country in the system. The colors depict the total number of publications in the respective years. The legend on the right side of the chart indicates that the darker shades towards the blue end stand for the early years of 2017, while the lighter shades towards the yellow end stand for the later years of 2022. The transition of colors represents the dynamics in the number of publications and points out the years in which the research was focused. If one zooms into the visualization, one can identify some of the biggest nodes, which are countries such as the United Kingdom, Germany, the United States, and Sweden. Specifically, the United Kingdom is identified as the country with the most documents on sustainability, 174, which have been cited 2981 times. Furthermore, the total link strength of 125 shows the interaction or connectivity the United Kingdom has with other countries. Germany, in particular, has 42 documents with a citation rate of 660, which may mean that the quality or significance of the publications is high. The total number of its connections is 83. The USA has the highest number of publications and citations, but the total link strength is 74, which is lower compared with the other countries. This means that these countries are key players in the research of sustainability in education, either as the top-publishing countries or the countries with the highest collaboration rates in the field.

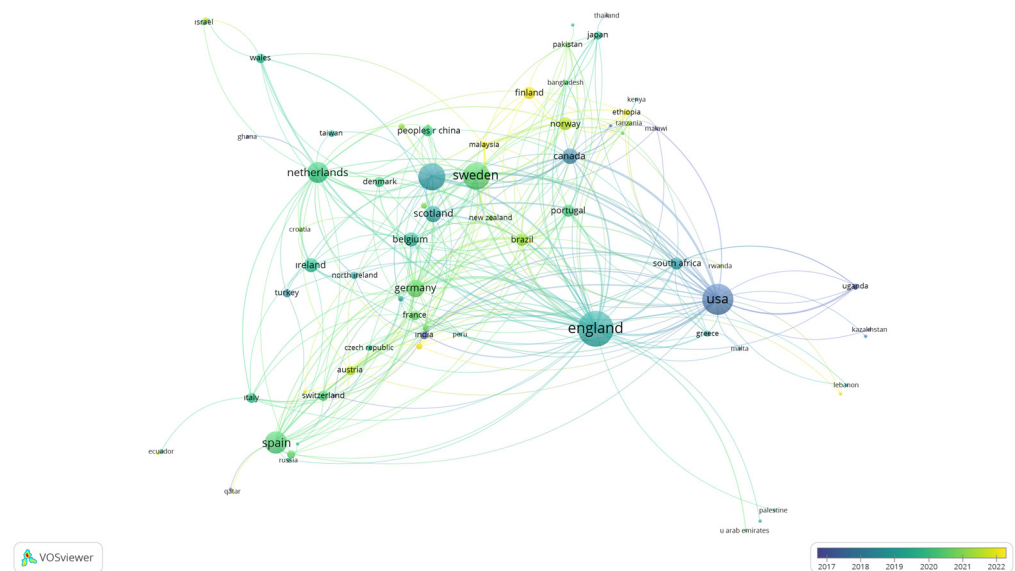


Figure 3. Research on sustainability in education by country.

Figure 4 illustrates institutional collaborations, total publications, and the distribution of total publications. The institutions are represented as nodes (points) on the map, and the size of each node depends on the number of publications of a given institution in this field. The connecting lines reflect the cooperation among institutions, for example, co-authorship of publications, and the thickness of the line refers to the intensity of this cooperation. The colors show how many publications were published in a given year; a darker color shows that the publications were issued in 2016, and a lighter color shows that the publications were issued in 2022. Among the large nodes in the visualization of the map, it can be

seen that some of the most active and well-known institutions in the field are displayed. For example, Manchester Metropolitan University has 19 publications, 449 citations, and connection strength of 71. There are 13 publications, 193 citations, and connection strength of 63 for Hamburg University of Applied Sciences. The University of Passo Fundo has 6 publications, 46 citations, and connection strength of 24. Thus, these institutions have high numbers of publications related to sustainability in education together with vast connections with various stakeholders in this field. These findings help to clarify the structural properties of academic networks and identify the scope of collaboration within the academic environment. This analysis is also useful in understanding shifts in research topics and interactions among scholars over time.

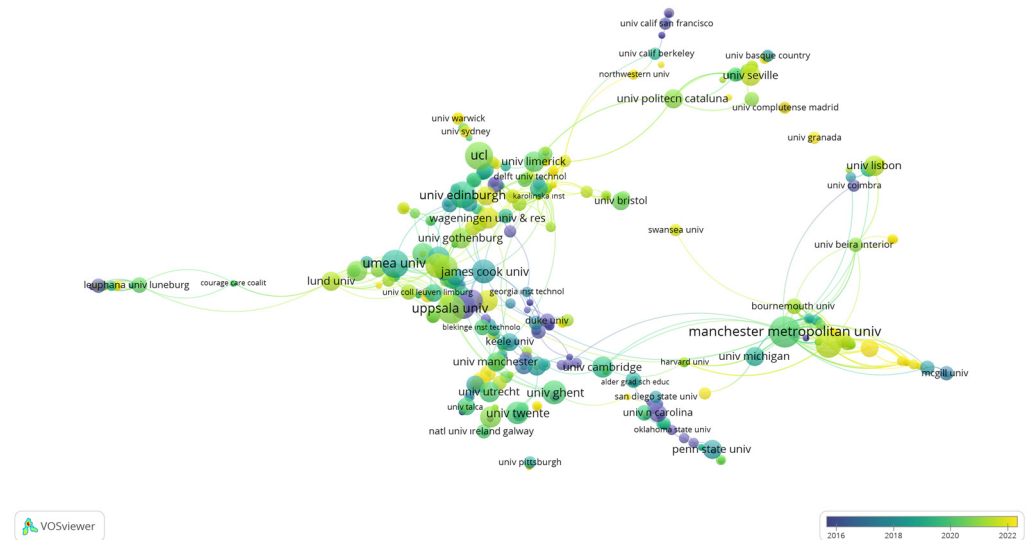


Figure 4. Research on sustainability in education by universities.

Figure 5 shows the academic distribution of publications on sustainability in education across various academic journals. The name of each journal is presented together with the number of articles published in that journal. International Journal of Sustainability in Higher Education has 118 articles, 2986 citations, and total connection strength of 55. Environmental Education Research has 117 articles, 1909 citations, and total connection strength of 94. BMC Medical Education has 44 articles, 350 citations, and total connection strength of 50. Thus, Figure 5 highlights which journals are prominent in this field. Such data can guide academic researchers, students, and others interested in the field toward the journals that are most active in this area and where they might consider submitting their research.

Figure 6 demonstrates how terms connected to sustainability in education are inter-related and how often they are applied in the literature. The word “sustainability” is written in the biggest font in the middle of the map, which reflects the focus on this topic in the research field and the most highlighted topic. The term “sustainability” is the most frequently used term in the abstracts, mentioned 196 times, with a total connection strength of 599, and occupies the central position in the investigated area of research. The term used second most frequently is “higher education”, which was used 95 times with a connection strength of 262. Other words are also used often and have a high number of connections and connection strengths including “education for sustainable development”, “sustainable development”, and “curriculum”. Other related keywords such as “universities”, “teacher education”, and “medical education” are placed in the context of “sustainability”, implying the role of such terms in the studies. The colors indicate the frequency of the key terms regarding the years they were published. In the color scale provided in the visualization, darker colors indicate the older years, and lighter colors, the recent years. This shows how the trend in the terms and concepts changed over the years based on the general populace

and scholarly interest. The map also shows how the research on sustainability in education is an interconnected field and how this term is connected with other fields of education. It also proves that this topic is of great academic concern and is analyzed in a large number of scenarios. The key concepts that are frequently used when grouped are analyzed under four themes.

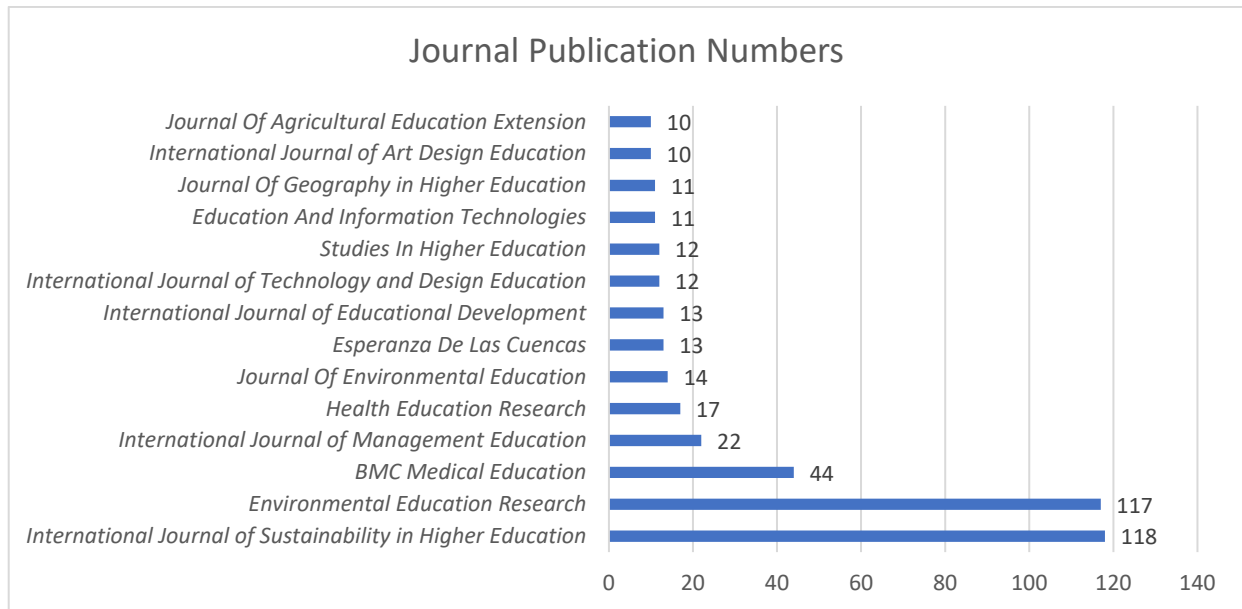


Figure 5. Research on sustainability in education by journal.

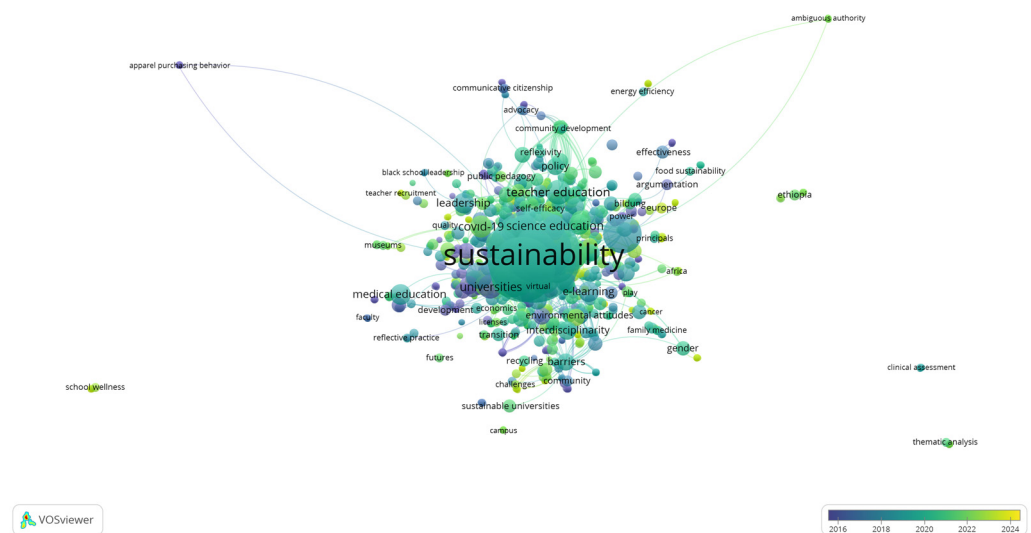


Figure 6. Research on sustainability in education by keyword.

The categorization of thirty frequently used key terms into four broad categories in Figure 7 provides a synthesis for addressing the concept of sustainability in the educational domain. Each category represents a critical dimension of sustainability in education. The first category is educational pedagogy. Educational pedagogy as the first category aims at identifying how educational processes and strategies are developed and implemented in relation to the concept of sustainable development. It involves curricula and instructional models and techniques that promote learning about sustainability in different educational stages. It also encompasses the creation of new approaches to introduce sustainability consciousness at different educational levels, including tertiary, secondary, and even preschool levels. It is also directed towards incorporating sustainability into the educational processes

and practices with the help of new approaches to teaching and learning and curriculum innovations that promote sustainability. The second category of sustainable development and environment involves embracing the principles of sustainable development in educational institutions. It addresses the task of preparing students to understand and respond to important environmental issues such as climate change and environmental conservation. It focuses on education as one of the most effective strategies for sustainable development and stresses that teaching students about their duties to the environment is the key to the development of sustainability. Thirdly, the institutional and professional development category focuses on the developmental processes of institutions and professionals in education. It promotes continuing professional development that empowers educators for positive and sustainable educational practices. This aspect points out the need for institutional support and resources in the development and capacity of educators with regards to sustainable teaching practices. The fourth category, educational content and curriculum, entails the development of educational content and curricula that reflect the principles of sustainability, ensuring that students are informed and skilled in terms of sustainable living. This facilitates the development of course content that not only educates learners about sustainability but also encourages them to practice sustainable behaviours. This approach involves a comprehensive integration of education for sustainable development within and across disciplines in the educational system. This figure clearly shows that an integrated approach in the educational system is needed to achieve the goals of sustainable development. It is clear that an integrated approach is needed in educational systems to achieve the goals of sustainable development. Education is a crucial component in helping students acquire the knowledge, skills, values, and attitudes that are necessary for a future that is sustainable, and this reflects the importance of the relationships among the categories shown in Figure 7 in the process of building an education system that supports the concept of sustainable development.

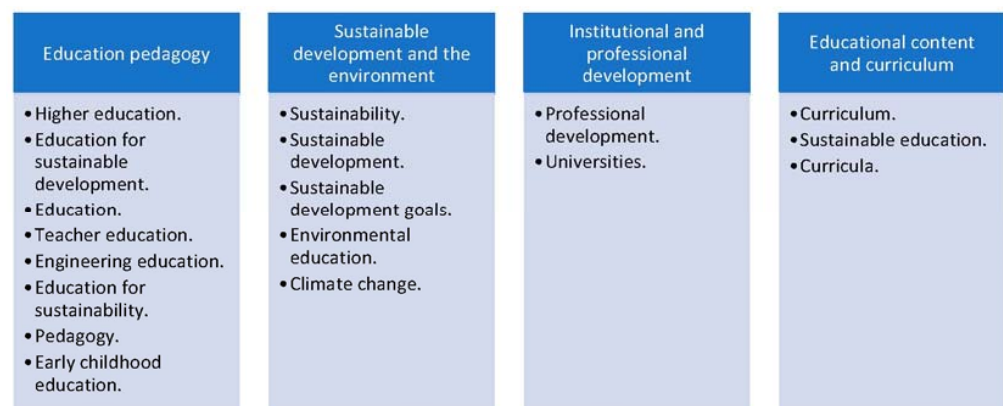


Figure 7. Categorization of keywords.

4. Discussion

This study shows that it is possible to identify the area where the field of educational research intersects with sustainability, as the importance of sustainable development has been realized globally. The goal of our study was to provide an overview of the current state of sustainable education in the scientific community by conducting a bibliometric analysis of the existing literature in which we examined key trends and developments, the most active authors, journals, and countries, as well as changes in the scientific discussion over the years. This discussion aims to place our findings in a broader perspective, make comparisons with other research studies, and enhance our overall understanding of the outcomes of sustainable education research by considering how the results relate to the research hypotheses presented in the current study. Based on this hypothesis, we anticipated that there would be an expansion of the literature and various types of studies focusing on sustainable education in the past five years in line with the growing global concern for

sustainability. The findings highlighted a trend towards a greater number of publications and topics ranging from environmental education to economic and social sustainability. This expansion reflects a gradually enhanced understanding of the multifaceted and trans-disciplinary nature of sustainability challenges and the importance of education in this context. The conclusions made herein corroborate Hallinger and Nguyen's research on the progressive enhancement in publications regarding the theme of education for sustainable development within the last three decades [13]. Both papers identify increasing scholarly concern towards the implementation of sustainability within educational systems, thus pointing out the emergence of a new paradigm within the discourses on sustainability, which is not restricted to the mere environmental aspects but includes social and economic ones as well. Such growth is justified by the need to address the global concerns of sustainability and acknowledges education as a driving force in creating a society that is conscious of sustainability. As Grosseck et al. (2019) also pointed out, the current body of research in the field is characterized by thematic proliferation from environmental education to a more comprehensive understanding of economic and social sustainability.

Among the research themes in the field of education, education for sustainability is one of the most important topics that takes into account the concept of sustainable development worldwide. Therefore, the purpose of our work was to provide an overview of the state of research in the field of sustainable education using bibliometric analysis and analyze trends in scientific production, prominent authors, and the development of the scientific debate over time. Thus, based on the observed trend in the literature towards the growth and diversification of the subject of sustainable education, we assumed that in the past five years, there would be the same trend. The findings of this study supported the existence of a significant rise in publications and issues covered ranging from environmental education to economic and social aspects. This expansion indicates a growing recognition of the complex and interdisciplinary nature of sustainability issues and the critical role of education in addressing them. Our findings support Hallinger and Nguyen's (2020) documentation of a significant increase in publications related to education for sustainable development over the last thirty years [13]. Consistent with the observations of Grosseck et al. (2019), our research identified thematic diversity within the field, moving from a focus on environmental education to incorporating economic and social sustainability more broadly. This expansion corresponds to the United Nations Sustainable Development Goals [7], emphasizing the necessity of an educational paradigm that addresses sustainable development's triple bottom line. The identification of themes like sustainability literacy, green curricula, and sustainable campuses in the current study is in line with Zhang and Wang's [15] observation of an expanding thematic area of sustainability in higher education research. Our evaluation also indicates the growth of geographical distribution and international partakers in sustainable education studies. Contrary to the studies by Machado and Davin (2023) and Dođru et al. (2019), which pointed to the emergence of a new tendency to study countries, other than the United States, such as the United Kingdom and Germany [14,17]. All three works underline the significance of international cooperation in regard to the development of sustainability education, as the authors of the studies acknowledge that sustainability challenges are global issues that should be addressed on the international level.

Despite the WoS database being considered one of the most comprehensive and frequently used bibliometric analysis databases, it is essential to consider its limitations. WoS is very particular with the lists of journals that are indexed, which mostly comprise high-impact-factor and well-reputed journals. This can result in a coverage bias where work appearing in less indexed journals or new specialties is not adequately represented. WoS is well-indexed in sciences, particularly in natural and life sciences, but may have relatively weaker indexing in the social sciences and humanities. This may impact how interdisciplinary areas such as sustainability in education, which crosses over various fields, are represented. WoS primarily covers articles in English, and only 15% of WoS articles are indexed in languages other than English. Consequently, there is a risk that

important research conducted in other languages may remain unnoticed, which will reduce the number of approaches taken into consideration. Metadata accuracy and consistency in WoS, as in any other database, may be influenced by a number of factors, and problems like highly linked data and keyword tagging impact the precision of bibliometric analysis.

5. Conclusions

Based on the presented bibliometric analysis, several main conclusions about sustainability in educational research were established in the course of this study. It should be noted that the number of publications in the specified field was significantly higher in the years 2018–2024 compared to previous years, which suggests an increase in interest in this issue and awareness of its relevance. This surge can be attributed to the global shift towards sustainable development goals and the recognition of the centrality of education in the achievement of the said goals [31]. Manchester Metropolitan University, Hamburg University of Applied Sciences, and the University of Passo Fundo are among the most significant stakeholders that have become more visible in the discussions about sustainability in education. Some of the important journals that aid in the spread of knowledge on incorporating sustainability into curricula of higher education and the spread of sustainable development include the “International Journal of Sustainability in Higher Education” and “Environmental Education Research”. The distribution of the research across geographical locations confirms that the discussion on sustainability in education is global with countries such as the United Kingdom, Germany, and the United States of America being more enthusiastic in the discourse. The data obtained also indicates that the U.K. is the most productive country in terms of the number of publications and citations, which may be attributed to a well-developed research culture and a clear focus on the development of sustainability in education. This study also reveals that education plays a core role in the achievement of sustainable development goals and also notes that more research and innovations are required in this area. Based on the results of this study on the distribution of the source and institutional contributions to sustainability education research, the authors recommend multi-disciplinary collaboration and information sharing worldwide because these issues are global in nature. Highlighting the research gaps and future trends mainly in developing and underdeveloped countries acts as a catalyst for researchers, policymakers, and educators to focus on areas like curriculum development, teacher training, and implementation of sustainable development education from the primary level to the tertiary level. Education is one of the most important fields that can help create a sustainable future; there is no doubt that there should be further research and implementation of new ideas and practices in the field of education. The relationships among sustainability issues are highlighted together with the role of education in tackling the challenges. This underlines the importance of mainstreaming sustainable development in higher education and education for sustainable development to prepare future generations for a sustainable world.

6. Future Research

Regarding the next steps, there is a need for more quantitative research examining the efficacy of the measures in the promotion of sustainability education and studying the conditions and best practices for the dissemination of such measures all over the world, including different cultures and educational systems. This development should be performed in developing and underdeveloped countries through further research. Moreover, conducting research on the impacts that education for sustainability has on learners' attitudes, behaviors, and choices of careers and the exploration of how education fosters sustainable change in societies for the better is significant in the development of theory.

The bibliometric assessment offered in the current study provided a detailed quantitative evaluation of the research area under the umbrella of sustainability education. To complement this appreciation with qualitative data, we plan to carry out an integrative-

triangulated research study. Supplementary to this, the most frequently occurring keywords or pieces in the literature could be used to establish an empirical and thematic analysis of how these themes are approached and discussed qualitatively. Such research would entail assessing all of the information provided in frequently cited articles and other leading publications to evaluate the stories, arguments, and voices of prolific researchers. In combination with a bibliometric approach and by making reference to practical interventions and qualitative studies, such research would contribute to the development of epistemic and practical communities' visions of sustainability education, promoting both academic research and the real-world implementation of changes in practice.

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