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Original article

Sustainable Education at Higher Education Institutions (HEIs) and the COVID-19 Pandemic: A Bibliometric Review Study Field Review

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Abstract

Introduction. Recent environmental concerns over global warming and climate change together with the calls for sustainable development highlighted the importance of sustainable education aimed at preparing the new generations to come for the universal challenges facing humanity. All of that has been reinforced by the recent COVID-19 pandemic that brought about the digital surge in education. The interest in the topic of sustainable education can be demonstrated by the surge of research publications on this topic indexed in the Web of Science database from merely 22 in 1991 to 4055 in 2022. The main goal of this study is to provide a comprehensive review of scholarly sources related to sustainable education in higher education institutions and the COVID-19 pandemic.

Materials and Methods. The authors analyzed the vast body of recent research literature on sustainable education and conducted a field review. In total, 1115 results for the keywords "sustainable education" and "COVID-19" have been retrieved from the WoS database and subjected to the network analysis using VOSViewer software for identifying dominant trends, interconnectedness, and network visualization in the intersectoral research.

Results. It was found that there has been s a significant increase in interest for sustainable education during the pandemic in the research literature, highlighting the shift in educational focus. Five main thematic clusters of research have been identified, such as university student teaching, health policy services, economic impacts, Sustainable Development Goals, or higher education, with a strong emphasis on the student experience and institutional responses. Additionally, the interdisciplinary nature of research in this area has been proved, covering health, technology, economics, and social policies. It has been confirmed that these recent changes in sustainable education in higher education emphasize the need for multifaceted approaches to address the challenges posed by the pandemic on education sustainability.

Discussion and Conclusion. The challenges posed by the COVID-10 pandemic have made it increasingly clear that the higher education sector must go digital to succeed in a post-COVID world. Universities around the world must be prepared for future changes in industry, or they risk being left behind in an ever-changing landscape. The findings stemming from this study can be useful to ministries of education, various authorities and stakeholders, as well as to universities and higher education institutions themselves, both public and private, in the need to implement new approaches at all levels new bottom-up and on-the-ground approaches.

Keywords: sustainable education, higher education institutions, COVID-19 pandemic, bibliometrics, network analysis

Conflict of interests: The authors declare no conflict of interest.

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Оригинальная статья

Устойчивое образование в высших учебных заведениях и пандемия COVID-19: обзор источников

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Аннотация

Введение. Актуальные экологические проблемы, связанные с глобальным потеплением и изменением климата, а также призывы к устойчивому развитию подчеркнули важность устойчивого образования, направленного на подготовку новых поколений к решению всеобщих проблем, стоящих перед человечеством. Все это было подкреплено недавней пандемией COVID-19, вызвавшей всплеск цифровых технологий в образовании. Об интересе к теме устойчивого образования свидетельствует рост числа научных публикаций по этой тематике, индексируемых в базе данных Web of Science, с 22 в 1991 г. до 4 055 в 2022 г. Цель исследования – всесторонний анализ научных источников, связанных с устойчивым образованием в высших учебных заведениях и пандемией COVID-19.

Материалы и методы. Авторы проанализировали обширный массив современной научной литературы по устойчивому образованию и провели обзор источников. Всего из базы данных WoS было извлечено 1 115 результатов по ключевым словам *sustainable education* и *COVID-19*, которые были подвергнуты сетевому анализу с помощью программы VOSViewer для выявления доминирующих тенденций, взаимосвязей и сетевой визуализации в межотраслевых исследованиях.

Результаты исследования. Полученные результаты демонстрируют растущий интерес к развитию устойчивого образования во время пандемии, что свидетельствует о смещении акцентов в образовании. Выделено пять основных тематических блоков исследований – обучение студентов в университетах, политические услуги в области здравоохранения, экономические последствия, цели устойчивого развития или высшее образование (с сильным акцентом на студенческий опыт) и институциональные ответные меры. Доказан междисциплинарный характер исследований в этой области, охватывающий здравоохранение, технологии, экономику и социальную политику. Подтверждено, что восприятие темы устойчивого развития уже не является однозначным, а претерпевает изменения в глобальном дискурсе.

Обсуждение и заключение. Проблемы, возникшие в результате пандемии COVID-19, показали, что для успешной работы в постпандемийный период система высшего образования должна переходить на цифровые технологии. Университетам необходимо быть готовыми к будущим изменениям в отрасли, иначе они рискуют остаться позади в постоянно меняющемся ландшафте. Материалы статьи могут быть полезны министерствам образования, различным органам власти и заинтересованным сторонам, а также высшим учебным заведениям при внедрении новых подходов на всех уровнях по принципу «снизу вверх» и на местах.

Ключевые слова: устойчивое образование, высшее учебное заведение, пандемия COVID-19, библиометрия, сетевой анализ

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Introduction

The growing global attention to environmental issues such as climate change and the call for sustainable development have emphasized the importance of sustainable education in preparing future generations for the universal challenges facing humanity [1–3]. Nevertheless, it would also be fair to mention there are some opposing views showing that sustainable education following the Sustainable Development Goals (SDGs) merely implies mass education, which, as the experience of some countries demonstrates, might lead to the deterioration in the quality of national education [4]. Notwithstanding, the relevance of the sustainable education has been additionally emphasized by the COVID-19 pandemic, which triggered a digital revolution in education [5].

Higher education can be important in promoting sustainable development, and universities can use the SDGs as a platform for impactful action. The efforts of the United Nations (UN) in promoting sustainable development through initiatives such as the Sustainable Higher Education Development (SHED) demonstrate this quite clearly. The initiative is aimed at integrating sustainable development perspectives into higher education curricula and greening campuses [6–8].

Many educational systems, including the Nordic ones that are distinguished by their focus on sustainable education and awareness about global warming and climate change, made numerous efforts to promote sustainable development. For example, Sweden has taken a leading role in promoting sustainability initiatives such as its ‘Sustainability Initiative’ which encourages universities to research new strategies for promotion and integration of SDGs into their operations [9]. Other European Union countries have also taken similar steps by developing strategies to promote sustainable development through their higher education institutions, networks, and other operations, even though some other countries would probably disagree with some of these concepts as having relevance for their national development paths [10; 11]. It is important to understand the role that governments around the world can play in encouraging universities to integrate SDGs into their operations. Countries and governments should consider taking part in international events such as Rio+20, where they can make a concerted effort to strengthen SDG integration within higher education institutions and networks. By doing so, they would be able to support the global effort towards achieving a more sustainable future for all [12]. The United Nations promotes SHED which has culminated an ongoing transformation in the way education is perceived, included in the global agenda, and used as a tool for achieving sustainable development goals [13; 14]. The UN 2030 Agenda recognized that education is key to human health, growth, and development, and that increasing access to quality learning opportunities plays a central role in addressing climate change, ecological overshoot, and global human overuse of resources [15]. Since the launch of SHED, major progress has been made towards creating a more sustainable world. Goal 4 of the UN’s 2030 Agenda (“Ensuring inclusive and equitable quality education for all”) was identified as a core element of their mission to develop a sustainable future. This goal includes recognition that school enrollment rates have increased significantly over the past decade, but also acknowledges that there are still gaps in access to quality learning opportunities between different countries and regions [16]. The UN’s SHED initiative has therefore sought to address these issues by developing strategies aimed at improving access to quality education which can help reduce inequalities across societies while also meeting environmental targets such as reducing emissions or mitigating climate change impacts [17; 18]. The initiative has also sought to advance theory building by combining the theory of systemic evolution and sustainable higher education development for creating a linked underlying systemic framework. This framework can be used to not only substantiate ideas but also to guide research and sustainable

development in the scientific context [19]. It focuses on the sustainability of education by recognizing the importance of environmental skills and knowledge for students [20]. This model looks at how Higher Education Institutions (HEI) can promote awareness through personal actions and create a readiness for sustainable development among students. As a result, many national core curricula now include sustainable development as part of its educational framework, which is a major step towards promoting sustainability in education [21].

All of this encourages HEIs to train students in the abilities needed to act towards sustainability and develop qualities that will help them connect these skills to everyday life [22]. Vocational education establishments are also encouraged to integrate sustainable education into their curricula and increase student knowledge on issues related to sustainability, such as climate change, natural resources management, and energy use. This holistic and interdisciplinary approach to sustainable education can lead to the development of educational, research and innovation strategies that will ensure the sustainability of university life and create an education that meets the pressing needs of society [23; 24]. The UN also encourages universities around the world to strategically strategy their operations to promote sustainable development in government universities. The organization set an aim for all universities worldwide, limited financial means notwithstanding, for them to become active agents in promoting sustainable development through environmental initiatives such as efficient energy use, waste reduction and recycling efforts [25]. This aim is part of the UN's 2020 report on SHED and its recent proposal for sustainable development in education. The Rio Declaration (1992) and the United Nations 2020 report have identified several issues that need to be addressed to meet the SDGs. These include road safety policy development, food insecurity, pandemic, continued natural environment degradation, and persisted dramatic levels of poverty [26].

In spite of the relevance of the "sustainable education" topic in the international research agenda, it cannot be looked upon as totally unmistakable and indisputable. It needs to be recalled that the "green" or "climate" agenda can often become political instead of scientific phenomenology while replacing the economic component in sustainable development with some researchers even questioning the issue of renewable energy in mitigating climate change [27]. In addition, sustainable development might also bring about adverse effects such as "greenwashing" (using environmental agenda for increasing profits via misleading marketing techniques) or simply making it a "buzzword" that can be used in any context without the reflection of the current economic, social, or geopolitical context or national interests.

In general, the rising interest in sustainable education is evident from the increase in related research publications in academic literature. The Web of Science (WoS) database, which is considered one of the most prestigious academic databases in operation up to date, recorded the growing number of publications related to sustainable education from mere 22 in 1991 to 4055 in 2022. Our paper focuses on sustainable education at HEIs during and after the COVID-19 pandemic via conducting a thorough and structured bibliometric review study and deriving results for practitioners and academics.

Literature Review

The recent COVID-19 pandemic has acted as a catalyst for radical transformations in higher education approaches, creating an urgent need for digital transformation [28]. The global coronavirus outbreak has forced universities to move their training processes and distance learning online, leading to the emergence of insightful webinars conducted by higher education experts [29; 30]. This shift has highlighted the innate technological capabilities of universities, enabling them to deliver good teaching with relative ease. In fact, this pandemic is facilitating unprecedented transformation in the digital delivery of education and training [31]. The speed and agility with which universities have embraced digital technologies have been remarkable. Universities are now using virtual classrooms and e-learning platforms that enable students to access educational content from anywhere in

the world at any time they want. Furthermore, they are leveraging social media platforms such as YouTube, Instagram and Twitter to engage with students on a more personal level [32; 33]. By doing so, they can provide timely support when needed while also helping students stay engaged in academic activities even during times of isolation or disruption due to COVID-19 restrictions.

It is understandable that COVID-19 pandemic is enhancing the sustainable development of teaching in higher education through its radical transformations towards digital delivery methods which allow universities worldwide to continue providing quality educational experiences despite these challenging times we face today [34]. This shift towards sustainability pedagogies, sustainability education and online instructional settings has pushed for the development of new educational paradigms that put an emphasis on sustainable consciousness and quality of the learning process [35]. Several research studies were conducted within higher education institutions to analyze how this shift has been affecting the various stakeholders involved in the educational sector, from teachers to students. For example, some studies conducted by a group of engineering students from a prestigious university in Europe found that despite some initial difficulties due to the COVID-19 global pandemic outbreak, these changes have improved their engagement with curriculum material and overall appreciation for their university's commitment towards providing quality teaching during such an unprecedented time [36; 37]. As technology continues to evolve rapidly, it is expected that COVID-19 will continue enhancing sustainability development in higher education through its digital transformations which allow universities worldwide to provide quality educational experiences regardless of their current circumstances [38]. The pandemic has provided an unprecedented teachable moment for the higher education sector to reevaluate their sustainability initiatives and devote greater attention towards the need for digital transformation [39]. Interaction channels such as virtual classrooms and digital platforms have enabled students to continue their studies without compromising on quality. Digital advancements also allow universities to expand their international reach, allowing them to better serve students worldwide [40]. Partnerships between universities and technology companies are being formed to capitalize on this opportunity which would allow them to make use of advanced technologies such as 5G networks or augmented reality solutions for teaching purposes [41].

The pandemic made it quite clear that higher education needs to adapt digital technologies in case it wishes to survive in the post-pandemic world. Universities and HEIs need to get ready for the future challenges to come, otherwise they would be made obsolete in the new educational landscape [42; 43]. One can only thank partners like Nokia in the example above for providing universities with the opportunity and helping them to move forward into a sustainable future for higher education institutions worldwide. As we adjust our educational systems in response to these changes, we must ensure that our learning environments remain up to date with current technologies while still maintaining the highest quality standards possible [44]. With COVID-19 continuing its global spread, this may be our only chance at ensuring long term sustainability within the higher education sector. There is a wide range of DELT strategies being implemented in response to the pandemic, with an increased focus on digital transformation [45]. Research projects were launched to explore how this digital transformation can best be applied to higher education. Open online courses and massive open online courses have been developed by project partners or disciplinary working groups as digital education has gone virtual and students can access lectures and other learning materials from home [46; 47].

In general, the implications of this digital transformation are far reaching. It has enabled students and faculty members alike to access the very latest health information regarding COVID-19 from anywhere in the world – something that was not possible pre-pandemic [48]. Further, it has enabled universities around the world to participate in collaborative projects and research topics across a variety of disciplines providing greater opportunities for interdisciplinary

collaborations than ever before [49]. Additionally, open online courses have provided more flexible options for both student learning and university staff teaching schedules that allow more time for focused study or discussion on individual topics or projects respectively [50; 51]. The COVID-19 pandemic has created an opportunity for policy solutions that could help promote a broader transformation towards advanced educational systems which are more sustainable and resilient. For example, some researchers suggest that the pandemic can facilitate more effective use of healthcare facilities, occupational health, and safety curriculum, as well as more efficient implementation of online educational tools. This is especially relevant for higher education institutions that are facing challenges in terms of resource scarcity or health concerns during the crisis [52; 53]. In a way, the COVID-19 pandemic is a global outbreak that has changed the way of how higher education institutions deliver their curriculum and how students learn. The digital strategy of the pandemic has enabled higher education institutions to maintain quality education while delivering structural change. This digital transformation can enhance sustainable development in teaching by supporting institutional values, such as sustainability consciousness and developing a sustainable society. By utilizing digital tools, higher education institutions can improve curriculum delivery and support teachers with the need to adapt quickly to dynamic changes [54; 55]. Moreover, this approach will help students adjust to new learning environments while also empowering them with skills that are essential for success in their careers. The COVID-19 pandemic has provided an opportunity for higher education institutions to rethink their strategies and approaches towards delivering quality education to build a more sustainable society for everyone involved. It has highlighted the need for better infrastructure, technology, and training resources which are crucial for the successful implementation of digital strategies within educational institutes [56–58]. Therefore, it is important that teachers have access to adequate training so they can effectively utilize these new technologies when delivering their curriculum during these challenging times.

In the past three years, several research projects have been conducted to evaluate the impact of the pandemic on the higher education sector and how it has changed teaching methods. The results from these studies indicate that online learning has enabled universities and service teachers to continue delivering learning materials to students during this period [59; 60]. It also revealed that student choices for their courses were highly influenced by the current research about their preferred subject areas, as well as a learner survey with feedback from second global learners [61]. Moreover, our literature review findings revealed that lecturers and teachers in the sector of higher education expressed positive attitudes towards technology-driven teaching and learning process while they remain concerned about its implications on pedagogical practices and students' outcomes [62; 63]. This means that higher education institutions should provide sufficient support for service teachers so they can successfully transition into online teaching platforms without compromising quality standards or student satisfaction levels. Furthermore, it is essential for universities to conduct periodic evaluations of their online learning systems so they can identify potential areas of improvement and respond accordingly.

Furthermore, the pandemic has posed significant challenges for leadership in higher education institutions. Leaders have had to make difficult decisions regarding the shift to remote learning and work, ensuring the safety of students and staff, and maintaining the financial sustainability of institutions. The pandemic has also highlighted the need for leaders to be adaptable and innovative in their approach to leadership. According to some researchers, effective leadership during the pandemic requires a focus on communication, collaboration, and innovation [64]. In addition, the pandemic has challenged the traditional leadership models in HEIs, which are based on hierarchical structures and face-to-face interactions. The pandemic necessitated a shift to remote leadership which created several challenges and burdens, including communication barriers and the need to adapt to new technologies [65]. Moreover, the crisis also highlighted the need for effective crisis

leadership, as HEIs have had to respond to the rapidly changing situation brought about by the pandemic. Effective crisis leadership has been critical in ensuring the continuity of academic activities and the safety of staff and students [66].

Apart from these academic strategies, many institutions have also focused on supporting the well-being and mental health of their students and staff during the pandemic. This has included the implementation of counselling and mental health services, as well as the creation of virtual support groups and social activities to help students feel connected and engaged despite the limitations of remote learning. Many HEIs had to shift their financial and operational strategies to address the financial impacts of the pandemic [67]. This included the adoption of cost-saving measures such as stopping hiring, furloughs, and reduced operating expenses, as well as the exploration of new revenue streams and partnerships to help offset the financial losses caused by the pandemic [68].

Materials and Methods

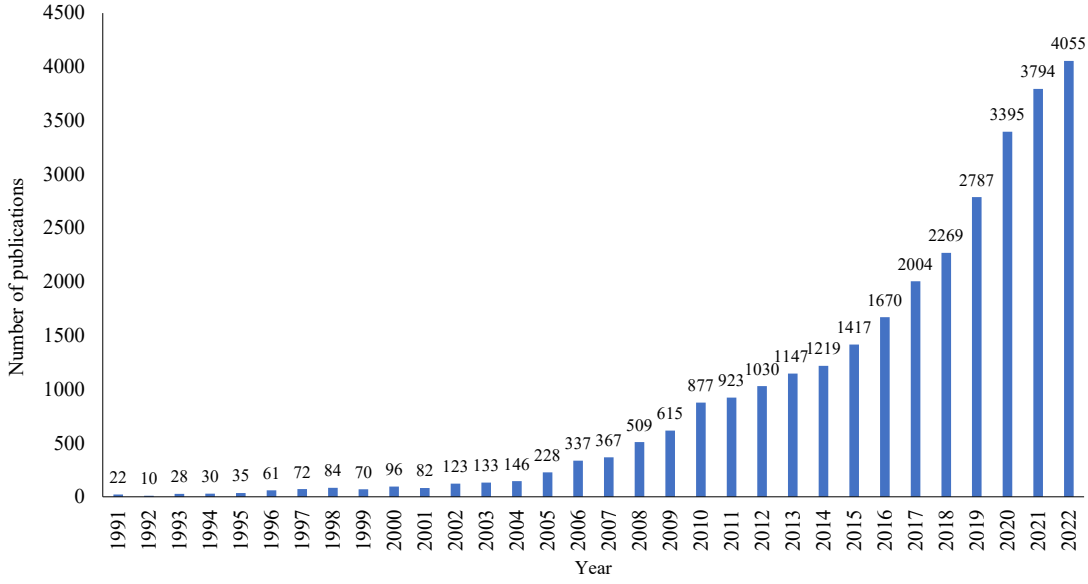
Our researchers included a comprehensive review supported by the thorough bibliometric analysis of recent studies on sustainable education. There were 32,697 results for "sustainable education" in the Web of Science Core Collection with the total number of publications on that topic rising from 22 in 1991 to 4 055 in 2022 (see Figure 1 shown below).

Furthermore, Figure 2 that follows provides an account of the most prolific institutions producing publications on higher education and sustainable development between 1991 and 2023.

One can see very prestigious institutions such as University of London, University of California, Harvard University, Monash University, or University of Sydney being among the top 10 ones (Fig. 2).

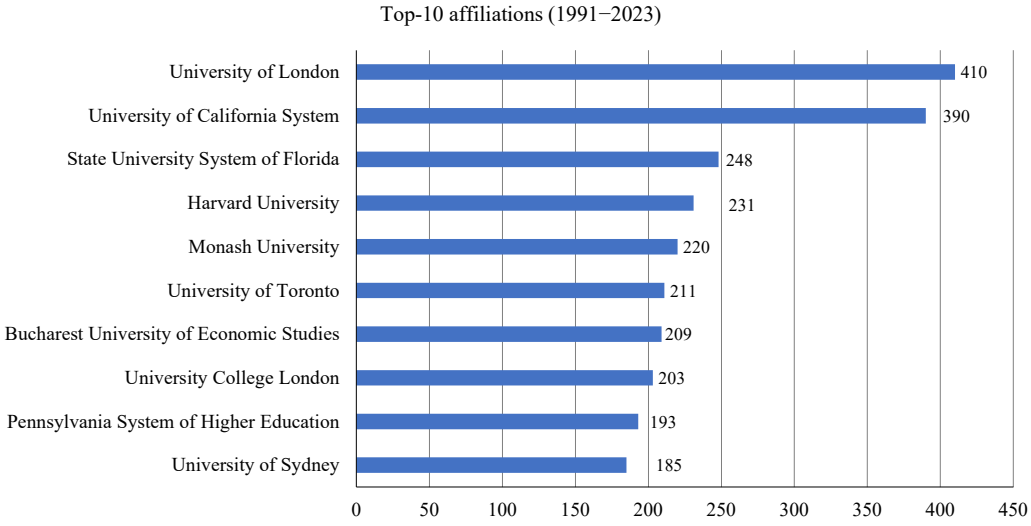
Additionally, Figure 3 below, an overview of the most prolific journals publishing articles and proceedings papers on sustainable education between 1991 and 2023. One can see that the share of the journals by the new publishers is growing compared to the share of the well-established journals published by the respectful publishers (Fig. 3).

In addition, we obtained 1115 entries from the WoS database using the keywords "sustainable education" and "COVID-19". These entries (represented hereinafter by journal articles, book chapters, and proceedings chapters) were then analyzed using VOSViewer v.1.6.15 software.



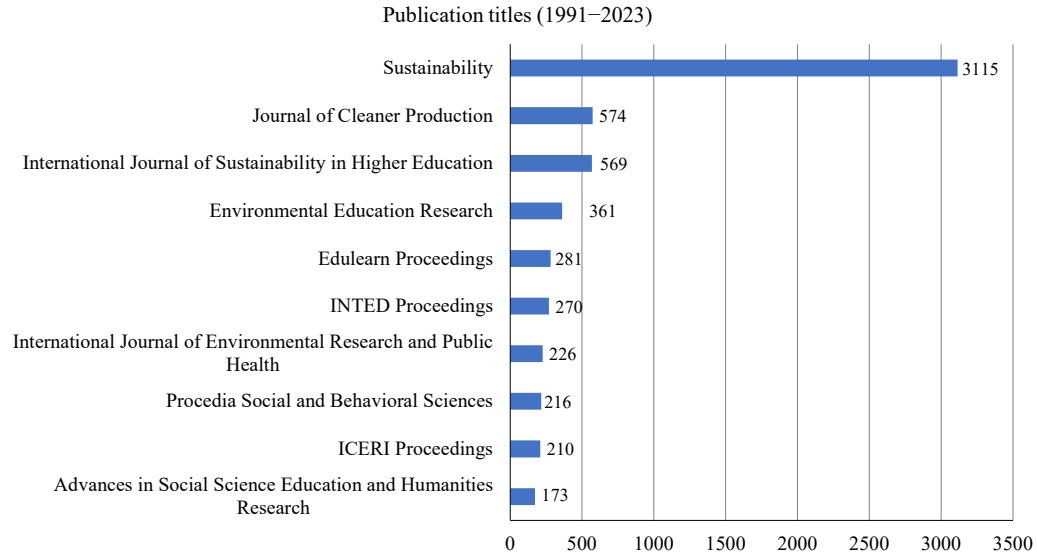
F i g. 1. Annual number of publications on sustainable education (1991–2022)

Source: Own results.



F i g. 2. Most prolific institutions doing research on sustainable education (1991–2023)

Source: Own results.

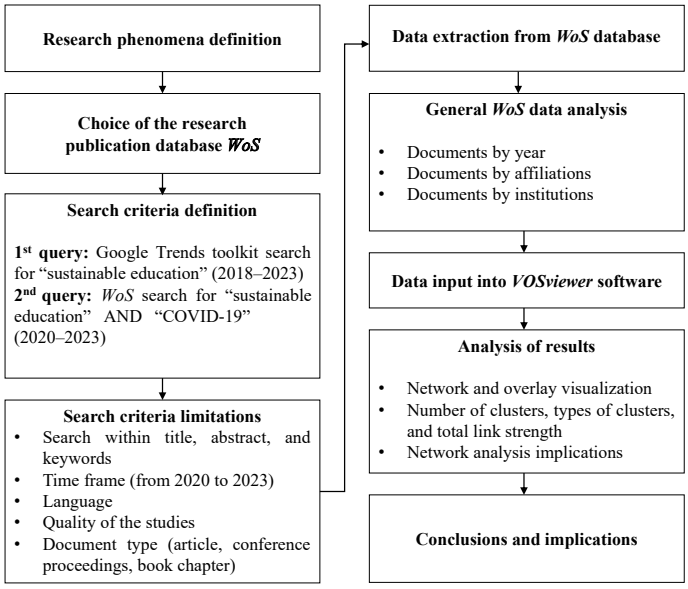


F i g. 3. Most prolific journals doing research on sustainable education (1991–2023)

Source: Own results.

The software is gaining a wide popularity nowadays among researchers conducting bibliographic analysis of various complex topics. VOSviewer is typically applied for network analysis to uncover prevailing trends, the interconnectivity between topics, and to visualize the networks within cross-sectoral research [69; 70].

Figure 4 that is presented above, demonstrates the main steps of the bibliometric data collection and network analysis applied to the extracted data which is based on the authors' own methodology used in similar studies [71; 72]. The next section presents the results of this analysis and draws main implications stemming from these results.

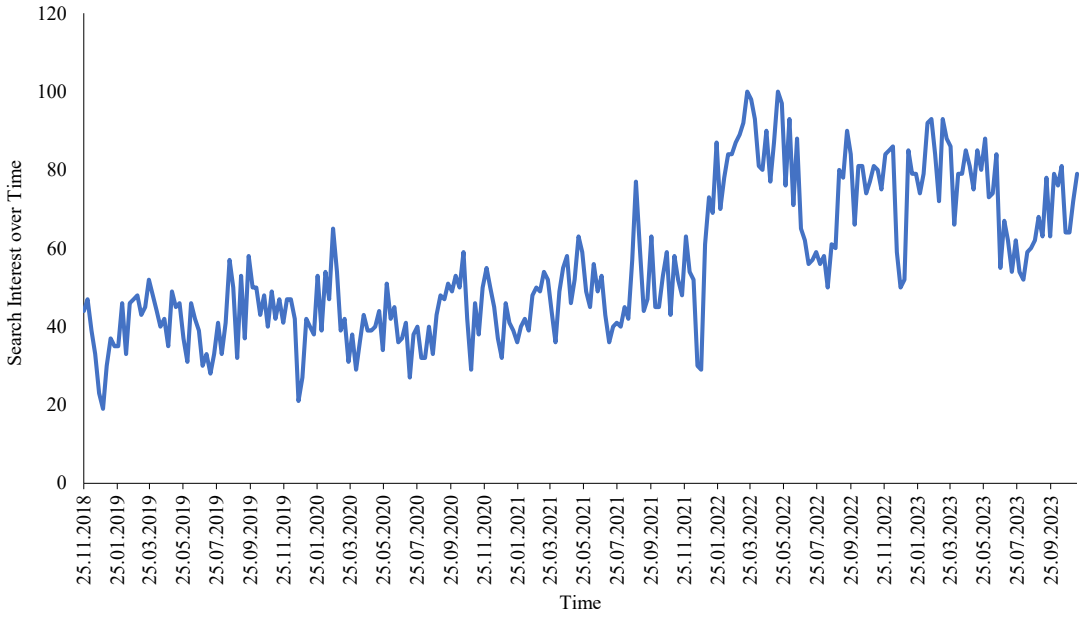


F i g. 4. Steps of the bibliometric data collection and analysis

Source: Own results based on the own methodology [71; 72].

Results

Figure 5 that follows depicts the results of the analytical scanning based on the Google Trends toolkit (which is recently popular with researchers analyzing online word searches and is based on searchers on Google search engine) showing the frequency dynamics of the worldwide search requests (simultaneous search for the group of items) for the term "sustainable education" for the last 5 years (from 2018 until today).



F i g. 5. The worldwide dynamics of frequency of search requests of the concepts of "sustainable education"

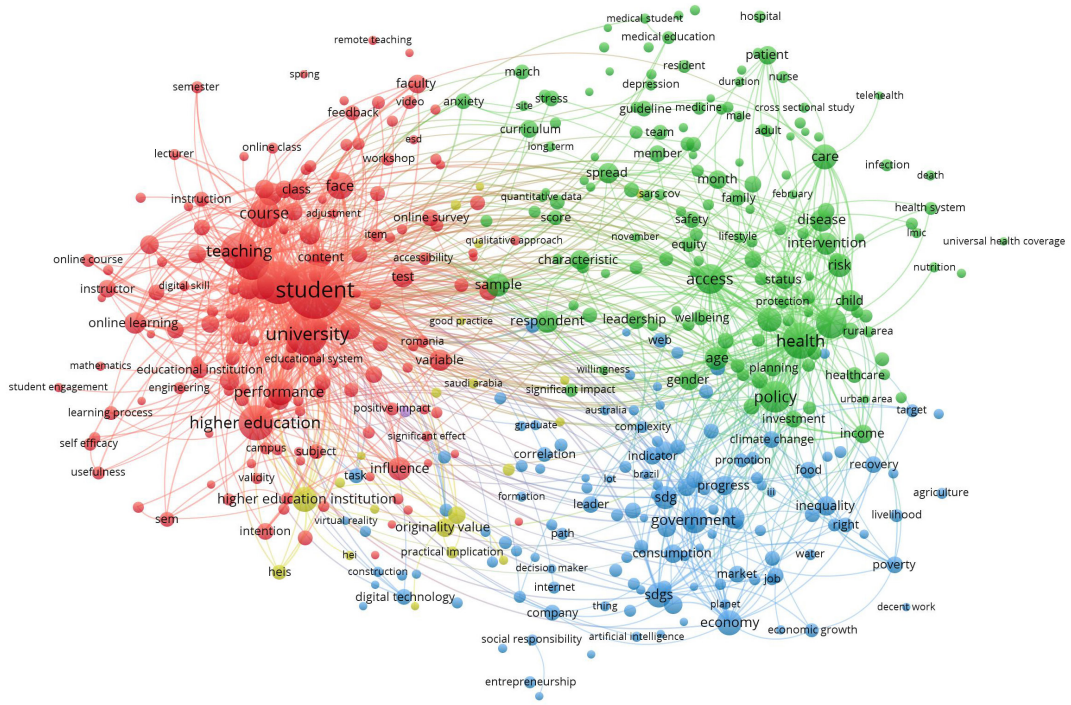
Source: Own results based on Google Trends.

The Figure features the metrics called "Interest over Time" (IoT) which assesses the search interest relative to the highest point on the chart for the given region and time (with 100 being the peak popularity and 0 showing that no data was available for the given region and time period). Looking at Figure 5, a visible increase in the search for sustainable education happened at the end of the first "pandemic year" of 2020. This proves the impact of the COVID-19 pandemic on the changing focus in education.

Then, we analyzed our 1115 results from WoS database retrieved using the titles "sustainable education" and "COVID-19" and indexed between 2020 until 2023. The resulting network map which was created using VOSViewer software visualizes the interconnectedness of terms from our dataset underscored the complexity of the challenges posed by COVID-19 to sustainable education and the diverse, interrelated research areas that have emerged as scholars seek to understand and address these challenges. In general terms, this visualization helps us to understand how different concepts are related and the centrality of certain themes in the discourse (see Figure 6 that follows).

The map is divided into five color-coded clusters, each likely representing a thematic concentration of research within the dataset. For example, a cluster may represent a focus on online learning, while another might relate to the health implications of COVID-19 on education. The proximity of the terms within clusters indicates how closely related the themes are in the literature. In total, there are 5 main clusters identified by the VOSViewer software: 1) University, student, teaching (red); 2) Health, policy, service (green); 3) Government, economy, SDG (blue); 4) Higher education (olive); and 5) Key factor (violet).

The most prominent nodes, such as "student", "university", and "higher education", are typically central to the network. These terms are likely the most common and pivotal within the research, suggesting a strong focus on the student experience and institutional responses to COVID-19 in the context of higher education.



F i g. 6. Co-occurrence map based on the text data

Source: Own results based on VOSViewer.

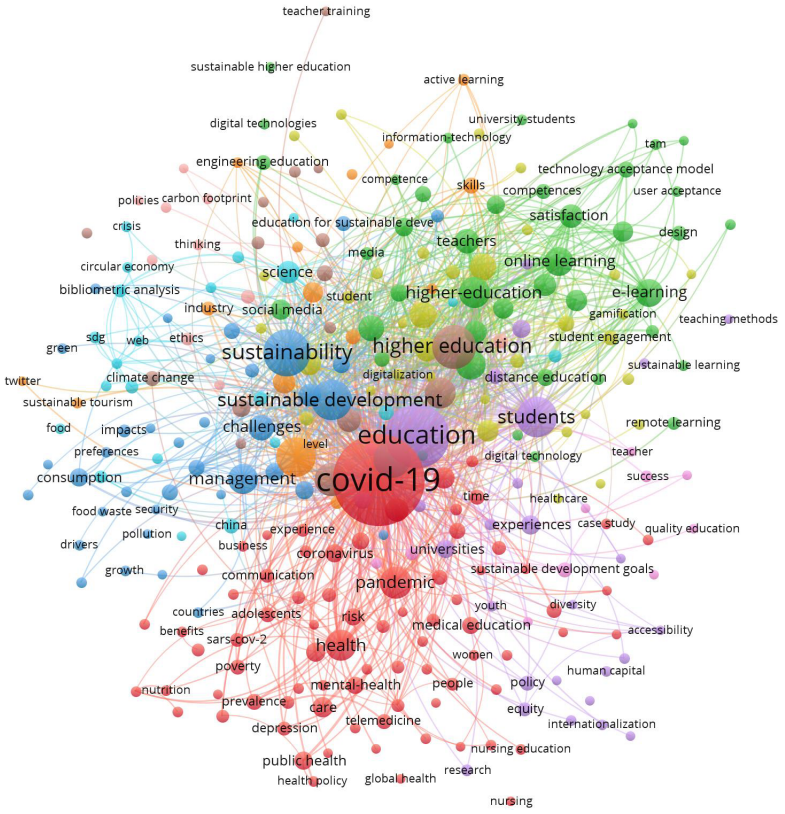
Moreover, the lines connecting different clusters illustrate the interdisciplinary nature of the research. For instance, a line connecting the "student" node in one cluster to the "health" node in another indicates that there is research exploring the relationship between students' experiences and health issues during the pandemic. In addition, the "policy", "leadership", "access", and "equity" terms highlights the practical applications for educational policies and management in times of the coronavirus pandemic. Furthermore, the terms "economy", "poverty", and "inequality" demonstrate the broader economic and societal implications for education in times of the pandemic. The growing importance of the technological aspects of education is underlined by the occurrence of such terms as "digital technology", "online learning", and "virtual reality".

In addition, the presence of country names (e.g., "Saudi Arabia", or "Brazil") and references to "SDGs" suggests a global perspective, with research examining the impact of COVID-19 on sustainable education across different regions and in relation to global sustainability goals.

Finally, the green cluster, featuring terms like "health", "well-being", "disease", and "nutrition", highlights a significant body of research concerned with the health aspects of the pandemic as they relate to education.

The network map shows that the impact of COVID-19 on sustainable education is a cross-sectoral issue, affecting various aspects of society and necessitating a multifaceted research approach that encompasses health, technology, economics, and social policies (Fig. 6).

Figure 7 shown above provides the results of the bibliometric network analysis. It is based on a bibliographic map based on bibliometric data such as co-authorship, keyword co-occurrence, citation, bibliographic coupling, or co-citation map). The results



F i g. 7. Bibliographic map based on bibliometric data

Source: Own results based on VOSViewer.

reveal the following patterns: The map displays clusters of terms in different colors, each likely representing a distinct thematic focus within the field of sustainable education as it intersects with COVID-19. These clusters may represent the most prevalent themes, such as "online learning", "health implications", and "sustainability measures". The terms "COVID-19", "education", "higher education", "sustainability", and "impact" are central and significantly larger, indicating their high frequency and centrality in the research discourse. This suggests a focus on the overall impact of COVID-19 on educational systems and practices.

The lines between terms represent their co-occurrence or relatedness in the literature. The dense network of connections indicates a highly interdisciplinary field with numerous overlaps between subtopics. In the cluster, there is a clear emphasis on "students", "online learning", "digital transformation", and "teacher training", pointing to a concentration on the transition to digital and remote teaching methods and the preparedness of both students and educators for these changes.

The red cluster, with terms like "health", "public health", "care", and "inequalities", highlights the intersection of health issues with educational practices during the pandemic, emphasizing the role of education in addressing health-related inequalities. References to "sustainable development goals" and "2030 agenda" suggest a focus on aligning education with broader sustainability targets, particularly under the strain of pandemic conditions. The inclusion of terms like "e-learning", "information technology", and "internet" reflects the technological pivot in education, which has been accelerated by the pandemic.

The map also touches on wider societal issues such as "inequality", "justice", "nutrition", and "climate change", indicating that the research on sustainable education during COVID-19 extends to encompass various social challenges and determinants. Additionally, the occurrence of the geographical names (e.g. "Vietnam", "Africa", and "Bangladesh") demonstrates both local and global perspectives of the research in the context of the challenges posed by the pandemic. In addition, terms such as "bibliometric analysis", "systematic review", and "case study" reveal what methodology is most often being used by the academic community for studying of the phenomena described above.

All in all, the network map reveals the extensive interplay between education, technology, health, and societal issues in the context of the COVID-19 pandemic. It suggests that the pandemic has acted as a catalyst for examining the resilience and adaptability of educational systems. The map indicates that addressing education sustainability during the pandemic requires a multifaceted approach, considering technological, health, social, and environmental aspects. It also implies a need for policy interventions and strategic planning in education to ensure it contributes to broader sustainability goals during crises. The diverse global context within the research signifies the importance of culturally sensitive and region-specific strategies in educational sustainability. The visualization supports the understanding that the field of sustainable education during COVID-19 is complex and multifactorial, necessitating collaborative efforts across disciplines and borders to create resilient and equitable educational environments.

Our findings stemming from this study reveal an increasing commitment to sustainable education in research literature. This represents a growing trend that is not limited to governments and state agencies but also embraced by universities and private entities. This surge in interest appears to have been further propelled by the COVID-19 pandemic, due to its health implications, lockdown measures, and the shift towards remote learning and the growing popularity of various management learning platforms and tools as well as their practical usage and application in tuition and lecturing.

Discussion and Conclusion

All in all, the COVID-19 pandemic has underscored the necessity for the higher education sector to shift towards a digital-centric model for its continued success in a post-pandemic era. Universities and HEIs must adapt to upcoming industry changes to avoid falling behind in a rapidly changing globalized and digitalized environment. This requires innovative, grassroots, and localized strategies

implemented at all levels by education ministries, authorities, stakeholders, and the universities and higher education institutions themselves, encompassing both public and private entities.

As the pandemic lingered, the universities and HEIs had to improve and advance their online teaching skills. In order to help instructors move classes online, classes and workshops were designed for training academic staff and faculty on how to best use technology for online instruction. To help meet this need, various forms of assistance need to be provided to instructors and lecturers in improving their online teaching capabilities. University mission, faculty, and staff worked collaboratively to confront the coronavirus pandemic by providing support to students and continuing work-based responsibilities with practices of co-production and knowledge peer support. Technology competence is supported through initiatives that critically evaluate best practices to ensure excellence of applications. As part of this effort, HEIs started to provide their students with access to course materials and resources in a variety of formats. Additionally, they supported human resource development for faculty and staff by offering workshops on how to adapt their teaching styles for online learning. These initiatives are geared towards helping instructors stay ahead of the curve in terms of technological competence and providing students with a quality education during these challenging times. The return of many students to college campuses brought with it a new set of challenges for higher education institutions. With the onset of the coronavirus pandemic, colleges and universities responded quickly by offering virtual classes, hiring tech support specialists, and training faculty on the use of digital platforms. HEI specialists helped faculty transition to remote teaching and provided guidance on how to engage students in meaningful online learning experiences. This became the ability to make a rapid transition to remote learning. The creativity and innovation that were facilitated by the pandemic proved to be remarkable and became a testament to the resilience of the higher education community. In the pandemic, faculty and staff needed to work together tirelessly to find ways to continue their work with creativity, enthusiasm, and dedication. Thence, the pandemic presented challenges to higher education institutions, but it also spurred their innovation and creativity. In the majority of cases, they responded to the crisis by developing digital initiatives that have allowed them to meet customer needs and expectations.

As customers, including many of HEIs, increasingly demand online interactions as a result of the COVID-19, many business companies needed to discover some new tools and technologies that could help them meet these needs. Companies also implemented measures that enable customers to interact with their businesses safely. Technology has played an essential role for successful companies during the COVID-19 crisis, as some of the first companies to embrace digital tools were able to remain competitive during this time. Additionally, these same companies were able to discover new ways of innovating within their industries. By utilizing technology in creative ways, higher education institutions have been able to continue providing services while meeting their students' expectations.

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