A Bibliometric Review of Research on Education for Sustainable Development, 2019-2023

Mira Esti Kusumaningrum[a,*], Heru Kuswanto[b], Jumadi[c], Slamet Suyanto[d], Suhartini[e], Desy Purwasih[f], Ratna Prabawati[g]

[a] **Corresponding Author:** Mira Esti Kusumaningrum, Science Education,Yogyakarta State University, Indonesia.
E-mail: miraesti.2022@student.uny.ac.id
ORCID: https://orcid.org/0009-0005-2908-7722

[b] Heru Kuswanto, Science Education,Yogyakarta State University, Indonesia.
E-mail: herukus61@uny.ac.id
ORCID: https://orcid.org/0000-0002-2693-8078

[c] Jumadi, Science Education,Yogyakarta State University, Indonesia.
E-mail: jumadi@uny.ac.id
ORCID: https://orcid.org/0000-0002-4055-5065

[d] Slamet Suyanto, Science Education,Yogyakarta State University, Indonesia.
E-mail: slamet_suyanto@uny.ac.id
ORCID: https://orcid.org/0000-0002-9581-0596

[e] Suhartini, Science Education,Yogyakarta State University, Indonesia.
E-mail: suhartini@uny.ac.id

[f] Desy Purwasih, Science Education,Yogyakarta State University, Indonesia.
E-mail: desypurwasih.2022@student.uny.ac.id
ORCID: https://orcid.org/0000-0002-4258-2059

[g] Ratna Prabawati, Science Education,Yogyakarta State University, Indonesia.
E-mail: ratnaprabawati.2022@student.uny.ac.id
ORCID: https://orcid.org/0009-0009-4834-069X

Abstract

The purpose of this study is to identify current research trends in the area of ESD. The SLR (Systematic Literature Review) method was used in this bibliometric investigation. Sourced from Scopus from 2019 to 2023, the database is used. Research on Education for Sustainable Development (ESD) has seen a significantly increased attention in recent years. Therefore, it is necessary to conduct a detailed examination regarding this matter promptly. This can help enhance our ability to identify study trends and better understand the character of the ESD method. Using a bibliometric approach, we identified 3,247 journal articles that containing the keyword "education for sustainable development". The results of the study show that scientific publications about ESD have relatively increased. After filtering with certain criteria, 60 articles were obtained. Consequently, Sweden contributed the most documents on ESD and the Futur Institute from Germany predominated in publications. The most contributing author is Gericle n. The research trends on ESD were grouped into five clusters, namely 1) ESD in the scope of learning; 2) ESD on educational programs and policies; 3) ESD linked to learning and teaching in practice; 4) ESD related to achievements or competencies in continuous learning; and 5) ESD related to continuous evaluation. Research findings can assist researchers to understand the ESD research trends and provide recommendations for further research directions

Keywords:

Education for Sustainable Development, Sustainable Development, Bibliometric, Review

Introduction

During the 1990s, educators were worried about the waste of resources and the negative impact of economic development on the environment, leading to an increased emphasis on environmental education (Jickling, B., & Wals, A. E., 2012). This marked the early stages of a concept that later known as "Education for Sustainable Development" (Aikens, K., et al., 2018; UNESCO, 2005; Jickling, B., & Wals, A. E., 2012). The international policy community has been raising awareness and integrating education into global policy initiatives with sustainable development goals, and these efforts have increased in the last two decades (Jickling, B.,

& Wals, A. E., 2012). An example of the efforts was the launch of the United Nations Decade of Education for Sustainable Development in 2004, to integrate the values, principles, and practices of sustainable development into formal and informal education (UNESCO, 2005).

Citizens of every nation need the education to pave the way for the development of knowledge and attitudes to create a sustainable society (Aikens, K., et al., 2018; Salas-Zapata, W.A., et al, 2018). The United Nations adopted 17 sustainable development goals (SDGs) reflecting the expansion of international efforts to create a sustainable society at the end of the 2015 Education Decade for Sustainable Development. Hallinger, P., & Chatpinyakoop, C. (2019) conclude that education is able to foster values, attitudes, and sustainable behavior among the next generation of global citizens, which is the key to achieving all of the SDGs, as well as providing the transformation required for sustainable nation (Kioupi, V., & Voulvoulis, N., 2019).

UNESCO defines Education for Sustainable Development (ESD) as a bridge for learners of all ages, knowledge, skills, values, and agency to address the interrelated global challenges of climate change, loss of biodiversity, unsustainable use of resources, and inequality (UNESCO, 2023) and empower communities to take responsibility for creating a sustainable future (UNESCO, 2003). ESD is an approach that combines behavior change, educational pedagogy, and knowledge continuity where the integration of these three things results in an effective and transformative learning process by empowering students to make informed decisions and take responsible actions for environmental integrity, economic feasibility, and just society for present and future generations while respecting cultural diversity (Redman, E., & Larson, K., 2011; Taimur, S., & Sattar, H., 2020).

Education is the most strategic way to instill and apply the values of sustainable development. In addition, education is considered the most strategic in encouraging sustainable development and increasing human capacity to be able to overcome environmental and development issues and problems. ESD is a multidisciplinary concept that views the concept of development from a social, economic, and environmental perspective (Vilmala, B. K., et al, 2022). The aim of ESD is to develop competencies that enable and empower individuals to reflect on their own actions by considering their current and future social, cultural, economic, and environmental impacts from a local and global perspective, taking part and being responsible for creating a sustainable community, and developing skills, values, and attitudes that enable people (including students) to lead healthy lives and be able to respond to local and global challenges (UNESCO, 2018).

Wals, A. E., & Lenglet, F. (2016) state that by the end of the 20th century, society will contribute to building a sustainable personality. Society is required to understand the complex world in which people live and understand how to deal with uncertainty, risk, and the high speed of social change. Communities must also be able to collaborate, communicate, and act positively in responding to world changes. To meet these demands, competence is required. UNESCO (2018) has defined eight main ESD competencies, namely 1) systemic thinking competence, 2) anticipatory competence, 3) normative competence, 4) strategic competence, 5) collaborative competence, 6) critical thinking competence, 7) self-awareness competence, and 8) integrated problem-solving competence. Each competency has its own qualities and areas of relevance. The eight competencies are interdependent and need to be developed basic competencies. In addition, basic competencies such as communication skills are very important to deal with sustainable development. (Wiek et al., 2011).

The importance of Education for Sustainable Development (ESD) is motivated by the alarming state of the Earth, such as floods, landslides, hurricanes, and global warming. Therefore, in addressing these issues, all parties need to contribute, including in the field of education with predetermined competencies. The potential of education as an effective means of solving problems on earth can be realized if the education system adheres to sustainable development (UNESCO, 2018).

Previous bibliometric studies were conducted to analyze the literature relating to sustainability and education in higher education settings. The topics analyzed included health, education, management, energy, agriculture, and environmental issues. The results showed that the largest publications were written in the US, UK, China, Australia, and Canada (Veiga Avila, L., et al., 2018). Similar research was continued by Hallinger, P., & Chatpinyakoop, C. (2019) with literature from 1998 to 2018, and the results of the author's co-citation analysis revealed three research groups that underlaid this knowledge base, namely Managing Sustainability in Higher Education, HESD Competence, and HESD implementation. Previous studies examined the HESD knowledge base from the perspective of implementation barriers (Lozano, R., et al., 2015; Velazquez, L., et al., 2005), teacher education (Chinedu, C. C., et al., 2018; Velazquez, L., et al., 2006), teaching and learning (Bostrom, M., et al., 2018; Ferreira, J.A., 2009; Rickinson, M., et al., 2008; Stanislas, M., et al., 2018), and conceptual models (Brebler, J. & Kappler, S., 2017; Scott, W., 2015).

According to this higher education research, Prieto-Jiménez, E., et al. (2021) concluded that the SDGs in general, SDG 4 regarding quality education, education

for sustainable development, higher education, and education management were the five core clusters identified in his bibliometric mapping analysis. In conclusion, the necessity of altering the purpose and role of higher education is emphasized more in order to address sustainable development.

According to relevant research on bibliometric review studies from ESD by Grosseck, G., et al. (2019), which retrieved 1813 papers from 1992 to 2018 using bibliometrics, these studies illustrate two main research directions for the entire time period, which involve integrating sustainable development into education and education into sustainable development. Moreover, research on Education for Sustainable Development (ESD) has expanded quickly, as seen by the rise in publications, authors, and journals. This is consistent with research findings from Hallinger, P., & Nguyen, V. T. (2020), which found that publishing rates have been rising quickly and that understanding of ESD has risen significantly over the previous 30 years. The bibliometric study methodology is further employed by Hallinger, P., et al. (2020) in additional research, this time related to simulations and serious games used in sustainability education from 1997 to 2019. This study provides a general summary of future research that will be conducted to support the effects of simulations and serious games on learner attitudes, knowledge, and behavior.

From the previous works, we can see that ESD may be examined from various fields. As a result, this study aims to continue and uncover the latest trends in ESD research. While earlier studies covered a wider range of topics, this study is more narrowly focused on schools and its surroundings. The bibliometric review of this study aims to expand on previous research reviews by mapping education for sustainable development from 2019 to 2023 with the required criteria. This review provides a benchmark for future research reviews on ESD, revealing emerging research trends from the interdisciplinary field. The research questions to guide the review of this study are as follows.

1) What is the output of publications, source documents, and language on ESD in the years 2019-2023?

2) What is the extent of the publication about ESD across countries and institutions in the world?

3) Who are the top authors researching ESD in the world?

4) What is the pattern of publication about ESD based on journals?

5) What are the results of the visualization of research trends on ESD?

Research Method

This study used bibliometric analysis and was expected to provide valuable references for future research. Briner, R., & Denyer, D., (2012) state that SLR plays a role in systematically collecting literature and providing descriptive analysis such as journal publications, trends, creating insights, to developing a base of knowledge on any topic. The steps of the SLR process followed were descriptions of Govindan & Hasanagic (2018); Mathiyazhagan et al. (2021) for this study with some modifications as needed. The database optimizes the Scopus database used in the initial phase to collect relevant articles. As Scopus uses consistent criteria to select papers for inclusion in its index, the author decided to use it as the document source for this evaluation. It also includes a greater selection of Web of Science papers to review social science and education research (Hallinger, P., et al., 2019; Mongeon, P., et al., 2016). Furthermore, Scopus provides more complex options for exporting bibliographic data than Google Scholar. The phrase "education for sustainable development" was used as a filter to search for titles, abstracts, and keywords from 2019 to 2023. Data collection was carried out in February-March 2023. A total of 3,247 documents met the search criteria. However, in the second stage, further screening was carried out to meet what was expected, such as open access documents, certain subject areas, and documents taken only from journals in English. Based on these provisions, 60 new documents were obtained. Later, the spreadsheet application program was used to analyze the data. A deeper analysis was conducted to analyze research trends, including publication output characteristics, document sources, distribution of countries and institutions, distribution of outcomes in the subject category, top authors, top citations, and publication trends from 2019 to 2023. The application or software used is VoSViewer to find out research trends on ESD. More detailed stages can be seen in Figure 1.

Findings and Discussion

Number of ESD documents in the 2019-2023

There are 3,247 articles related to ESD research in the Scopus database. All articles found were filtered based on the use of language, namely English. Then, the articles underwent a further screening process with certain criteria, such as All Open Access to facilitate access during cross-checking of data, keywords related to ESD and education, type of article document, and affiliations of eight institutions and top 15 countries, resulting in the amount of new data as many as 60 articles. The ESD research graph for the years 2019-2023 with these certain criteria can be seen in Figure 2.

Figure 1.

Summary of SLR of ESD stage with modification

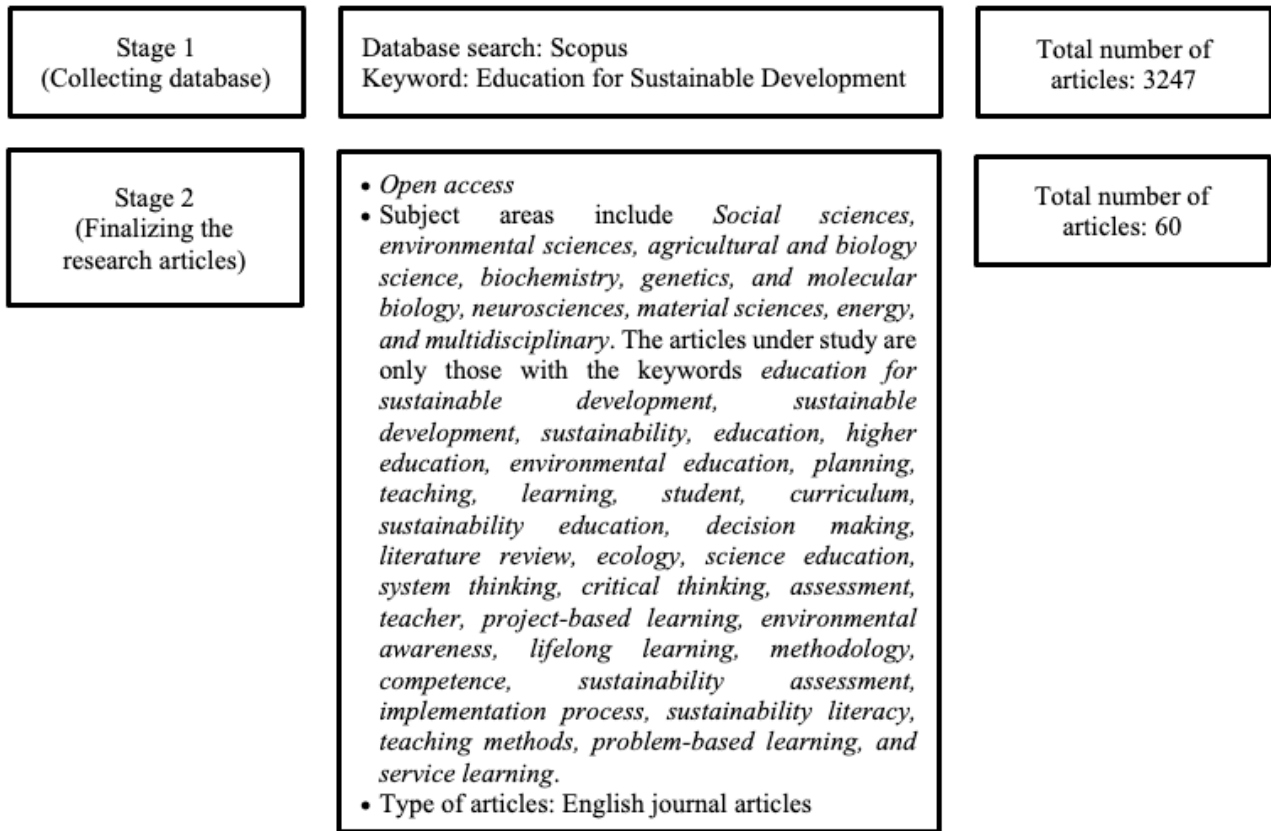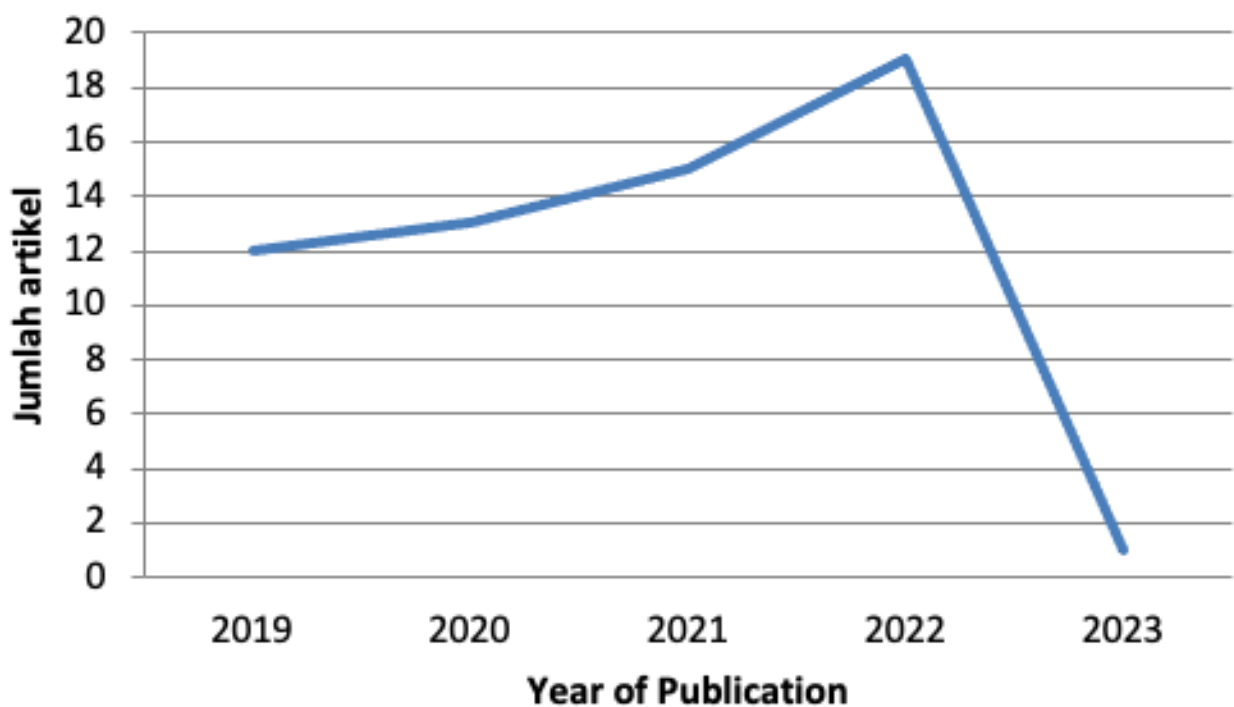| Stage 1 (Collecting database)	Database search: Scopus Keyword: Education for Sustainable Development	Total number of articles: 3247
Stage 2 (Finalizing the research articles)	• *Open access* • Subject areas include *Social sciences, environmental sciences, agricultural and biology science, biochemistry, genetics, and molecular biology, neurosciences, material sciences, energy, and multidisciplinary*. The articles under study are only those with the keywords *education for sustainable development, sustainable development, sustainability, education, higher education, environmental education, planning, teaching, learning, student, curriculum, sustainability education, decision making, literature review, ecology, science education, system thinking, critical thinking, assessment, teacher, project-based learning, environmental awareness, lifelong learning, methodology, competence, sustainability assessment, implementation process, sustainability literacy, teaching methods, problem-based learning, and service learning.* • Type of articles: English journal articles	Total number of articles: 60

Figure 2.

Number of ESD articles in 2019-2023

The number of publications from 2019 to 2022 is depicted in Figure 2 and shows an increase. However, the year 2023 indicates a decrease due to only one article being discovered. This is reasonable considering that 2023 had only been operational for three months at the time this study. Figure 2 displays the outcomes of the increased number of ESD documents. This is consistent with the findings of Hallinger, P., & Chatpinyakoop, C. (2019), which found that from 1998 to 2018 there was a growing tendency, despite seven years of marginally lower growth.

3247 documents were discovered after developing a search based on the concept of "Education for Sustainable Development" (searches continued until March 2023). 60 documents meeting a predetermined set of criteria were obtained. This study can be seen as a follow-up to earlier research conducted by other researchers. The majority of these studies, however, focus on particular aspects of sustainable development, while the focus of this research is ESD in education and all things educational. The annual increase in ESD research is depicted in Figure 2. This is achievable because, between 2000 and 2015, significant efforts were made to assist and improve the fundamental requirements of the world's poorest nations, one of which is education.

The best approach to establish morals and social norms in children, both formally and informally, is through education. As a result, education is highly essential in developing attitudes that support sustainable development. One of the most significant aspects affecting environmentally conscious behavior is education. The correlation between environmental awareness and knowledge demonstrates the value of education. According to research by Iswari, R. D., and Utomo, S. W. (2017), an individual's concern for environmental issues is positively connected with their knowledge of nature and the environment. It is hardly unexpected that ESD research is growing every year considering its significance.

Basically, the number of publications has been steadily increasing since the concept of ESD was officially recognized internationally. This shows that ESD is still an interesting research area. According to Wright, T., and Pullen, S., (2007), the creation and adoption of the 2030 Agenda for sustainable development along with the 17 SDGs by all United Nations member countries in 2015, provide a simple explanation of this growth. As a result, papers published after 2015 place greater emphasis on the role of education in achieving sustainable development.

Distribution of the countries of publication

For the distribution of 60 articles based on country of origin, in terms of collaboration between authors, 11 countries were selected that had ESD documents with a minimum of two documents produced, a number of citations, and strength of collaboration between authors. The detailed information provided in Table 1.

Table 1 shows that Sweden has the highest number of documents, namely 23 documents. This outcome was attributed to the publication of ESD policy documents by UNESCO (UNESCO 2004, 2014, 2017) which have had an impact on education policies around the world including Sweden's national guidance document for education (SNAE, 2013; Skolverket, 2011). Gericke, N., & Torbjörnsson, T. (2022) concluded that all types of schools that provide strategic priority to ESD in Sweden implement ESD, including in other countries such as Portugal (Spinola, H., 2015) and Belgium (Boeve-de Pauw, J., & Van Petegem, P. (2011).

Additionally, there was an increasing emphasis in Sweden on including ESD as one of the fundamental concepts of education. Swedish schools were making an effort to collaborate with ESD. ESD is an integral component of academic work rather than an exclusive approach to other school activities. The use of projects to assist student learning about sustainable development is a crucial strategy. The commitment of the teachers and administrators who support the work is a requirement for the success of the schools, all of which have a particular reputation in the field of ESD (Fredriksson, U., N., et al., 2020).

Table 1.

Distribution of articles about ESD in each country

Country	Documents	Citation		Total link strength
		Total citation	Citation per article	
Sweden	23	200	8.7	14
Germany	20	175	8.8	7
Spanish	14	169	12.1	1
Belgium	3	81	27	5
Norway	3	8	2.7	5
Portugal	3	36	12	5
Dutch	3	18	6	3
Taiwan	2	41	20.5	4
South Africa	2	14	7	2
United States	2	28	14	2
Indonesia	3	1	0.3	0

On the other hand, each nation has a unique cultural heritage and level of development, which might significantly influence their understanding of ESD (Wang, W., 2015). OECD member nations dominate the list of nations with the most publications and citations. This can be due to the fact that developing nations do not fund ESD-related research. The number of universities and research institutions in OECD member countries is higher than in non-OECD member countries, which may be contributing to the sharp rise in publications and citations from these nations. Wright, T., and Pullen, S., (2007) claimed that although bibliometric data may not unequivocally support this claim, it remains a factor worthy of consideration in future studies.

Next, the eleven countries involved in writing ESD then have a relationship that can be visualized in Figure 3.

Figure 3.

Relationship of the distribution of article origin

Indonesia has only one citation and does not have collaboration between authors and other countries, so it can be seen in Figure 3 that Indonesia was separated from other countries. In contrast to Sweden, which has been obliged to implement ESD, policies and implementation of ESD in Indonesia still need to be determined on a national planning scale (Suprastowo, 2010) even though Bappenas (National Development Planning Bureau) has compiled a National Medium-Term Development Plan document which contains all of the SDGs agenda within the national policy framework (Ministry of Education and Culture, 2021). Meanwhile, the interrelated relationships of the 10 countries in ESD research can be seen in Figure 4.

Figure 4.

Collaboration among authors in each country

Figure 4 shows the interconnections among 10 countries. Sweden has a larger circle and more connecting lines indicating that it has the most documents and author collaborations. Figure 4 displays the most significant nations in the field as huge circles, together with the degree of communication between nations as cooperating nodes. Figure 4 demonstrates how a number of nations frequently combine to form a single, sizable cluster, with an average of one or two core countries in each cluster. Three frequently mentioned countries in articles and citations were: Sweden, Germany, and Spain. On the other hand, other core nations include South Africa, Taiwan, Belgium, Norway, Portugal, Netherlands, and the United States. Due to the fact that ESD has drawn the interest of academics from all over the world, we can draw the conclusion that "geographical advantage is not the main factor influencing cooperative relations" (Liao, H., et al., 2018).

There are 157 organizations inside institutions that have published on ESD, according to cross-organizational results. The final six organizations are listed in Table 2 after additional selection was made based on at least two papers from each organization. The majority of research was conducted by institutions from Sweden, Germany, and Spain, the three largest countries, as shown in Table 2. In terms of the research activities carried out by each institution, the findings can be summarized into the following categories: There was no institutional coordination, each university from the three major countries tends to conduct its own research, and each work receives a significant number of citations. This is conceivable because the research priorities of various countries may differ.

Table 2.

*Number of ESD articles (2019-2023) of inter-organization*

Organization	Documents	Citation	Total link strength
Department of Computer Architecture, Universitat Politècnica De Catalunya—Upc-Barcelonatech, Barcelona, 08034, Spain	2	7	0
Department of Environmental and Life Sciences, Karlstad University, Karlstad, Sweden	2	6	0
Department of Pedagogical, Curricular and Professional Studies, University of Gothenburg, Gothenburg, Sweden	2	14	0
Institut Futur, Freie Universität Berlin, Berlin, 14195, Germany	4	55	0
Karlstad University, Karlstad, Sweden	3	73	0
university of gothenburg, goteborg, sweden	2	0	0

Top Authors in ESD Research

In the data processing related to the collaboration of the authors, a total of six authors related to ESD were produced. Among the six, three of them have the same collaborative power. This can be seen in Figure 5.

Figure 5.
Relationship of inter-author collaboration
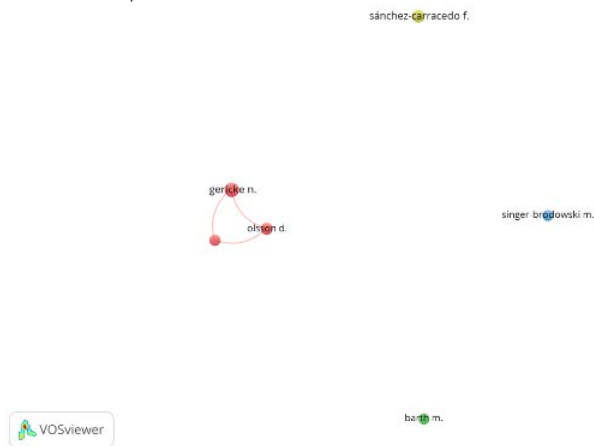
The explanatory data from Figure 5 can be seen in Table 3 regarding the number of documents, citations, and the strength of collaboration for each author.

Table 3.
Documents, Citation, and Top Collaboration Strength

Author	Documents	Citation		Total link strength
		Total citation	Citation per document	
Gericle n.	12	145	12.1	10
Olsson d.	6	100	16.7	10
Boeve-de pauw j.	5	99	19.8	10
Barth m.	5	39	7.8	0
Singer-brow-dowski m.	5	42	8.4	0
Sanchez carracedo f.	9	121	13.4	0

Figure 5 shows the collaborative relationship between authors, and it can be seen that the red relationship lines form a single bond with the names Gericle n., Olsson d., and Boeve-de pauw j. This indicates that the three of them have collaborated in writing about ESD and is supported by the data in Table 3, that the three have a relationship strength of up to 10. The "bubbles" in Figure 5 represent authors. The lines represent working relationships, whereas the nodes represent paper usage. The three authors of One Line have worked together on one or more publications.

In the map, collaborating authors frequently cluster together while non-collaborating authors are spread out. Basic issues like "Who collaborates with whom and how?" "Can past collaborations be assessed?" "What happened to collaborations between industry and universities?" etc. are typically the focus of cooperation analysis. Along with the quantity of coauthored works (publications), we should also consider "the extent to which co-authorship becomes international in the sense of collaboration" (Ellegaard, O., & Wallin, J. A., 2015) when describing the academic quality (impact) of a researcher.

ESD publication patterns based on journals

Table 4 illustrates the journals that have made the most significant contributions to ESD research, with the top five journals displayed. Sustainability Switzerland has the highest number of publications, with 23 articles. This is possible because the scope of the journal relates to sustainability. It can also be seen in Table 4 that the journals in which these publications appear are indexed in Scopus with Quartile Q1 and Q2.

As a result, ESD has garnered considerable interest among academics, particularly since many of its studies have been published in highly regarded international publications. According to the quartiles of these journals, there were 23 publications in Q2 and 17 in Q1, indicating that researchers generally adopt a modest publication strategy. The majority of research in this field displays good overall quality. The majority of the references pertain to environmental education and public health, thereby contributing to the dissemination of journals that help in assessing how different disciplines have an impact on the ESD domain.

Table 4.
Number of ESD Documents in Each Journal

Journal	No. of Documents	Scopus Quartile
Sustainability Switzerland	23	Q2
Environmental Education Research	7	Q1
Journal of Environmental Education	5	Q1
Journal of Cleaner Production	3	Q1
International Journal of Environmental Research and Public Health	2	Q1

*Trends of ESD Research in 2019-2023*
Figure 6.
Overall Profile of ESD Research from 2019 to 2023
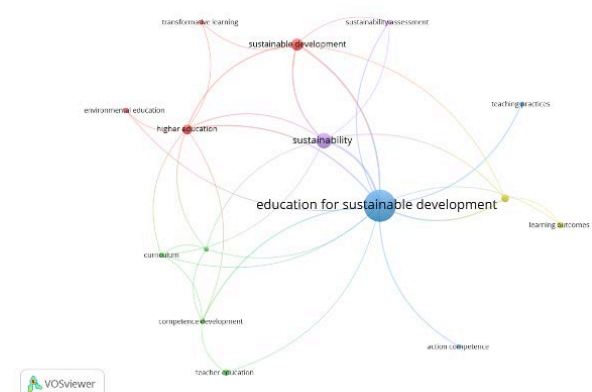
Among the 60 articles related to ESD research in the Scopus database, research trends on this topic can be visualized using the VoSViewer software. This effort helps find research novelty. The findings show that there were several parameters or interrelationships between variables in ESD, such as research on education for sustainable development, sustainability, sustainable development, higher education, environmental education, ESD with higher education, ESD on competencies, and curriculum policies. Figure 6 shows a visualization of the overall research on ESD. Researchers around the world produced five clusters.

The first cluster was ESD in the learning environment. The second cluster was ESD on education programs and policies. The third cluster was ESD which is related to learning and teaching in practice. The fourth cluster shows ESD related to achievements or competencies in continuous learning, and cluster five was ESD related to continuous evaluation. Nearly every word or subject in each cluster has a connection to the phrase ESD. The main subject field in which the research was conducted and the potential issues with ESD are both indicated by the fact that each word has at least one relationship to the others. The large blue ESD circle with lines connecting it to other keywords may be seen in Figure 6. This demonstrates the significance of ESD as a study issue.

Figure 7.
ESD in relation to teaching
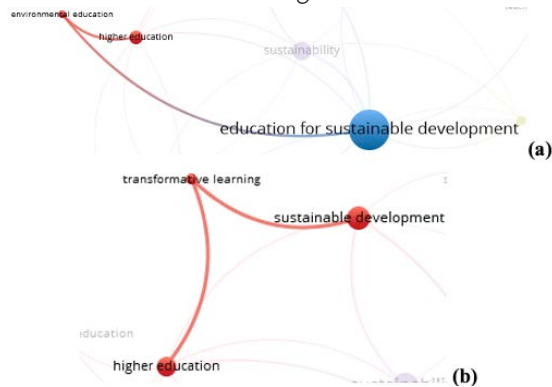
In Cluster 1, as shown in Figure 7, ESD was closely related to higher education, transformative learning, sustainable development, and environmental education. However, upon closer examination based on the keywords, higher education, transformative learning, and sustainable development were not directly related to ESD. It is different from environmental education which is related to higher education, both of which are directly related to ESD. Even so, the four keywords can be made into one cluster on the basis of the scope of learning.

Figure 7a demonstrates how ESD and environmental education were related. Environmental education in the narrow sense is essentially promoted by some UNESCO programs that use limited environmental interpretations; other programs interpret the environment more broadly and considering social factors; still other programs use ESD frameworks or incorporate ESD themes and approaches to reframe existing curricula and still refer to them as EE. The quality envisioned by transformational education should instead be used as the benchmark for evaluating EE and ESD rather than only one another (Plavova, M., 2013).

Next, figure 7b shows how sustainable development was connected to higher education and transformative learning. As it addresses common research topics like comprehending ESD definitions, concepts, curricula, or theories, exploring global research agendas and practices on ESD, mainstreaming ESD into educational policies, etc., sustainable development is a crucial topic throughout the period (Grosseck, G., et al., 2019). Transformative learning, on the other hand, can support ESD because its goal is to encourage critical self-reflection, which results in a shift in perspective and a change in behavior. Our obligation to ensure that these changes in perspective and behavior are rooted in restorative principles is at the core of the saguf message and program (Balsiger, J., et al.).

The global sustainability agenda has a substantial impact on higher education for sustainable development (HEfSD). Many higher education institutions actively working to incorporate the Sustainable Development Goals (SDGs) into HEfSD policies, curricula, and practices through sporadic and isolated initiatives. These institutions are responsible for preparing the next generation of sustainability leaders with the necessary knowledge and skills.

The success of HEfSD in policy, curriculum, and practice is largely contingent on a deeper understanding of what is already in place, according to research findings (Franco, I., et al., 2019). Gaps, focus areas, parallels, and divergences exist among regional HEfSD agendas. In order to successfully integrate HEfSD into policies, curricula, and practices that align with the SDGs and the overarching goals of the Global Agenda for Sustainable Development, it is expected to provide both conceptual and practical tools to higher education institutions and stakeholders across regions.

Figure 8.
ESD in relation to educational policy programs
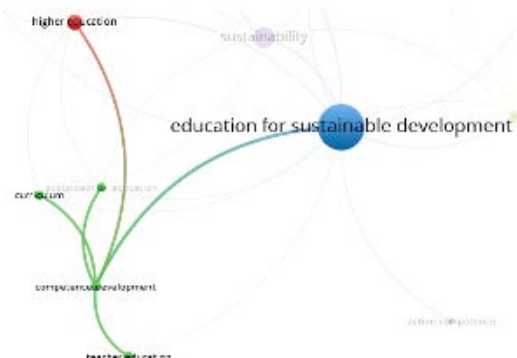
Furthermore, curriculum, sustainable education, competence development, and teacher education are grouped into one cluster and are closely related to ESD. Figure 8 shows that the four keywords are also related to higher education. This is possible because more research has been conducted at the higher education level. Thus, the four keywords are grouped into one cluster on the basis of education programs and policies.

Considering the United Nations Decade for ESD (2004-2015), competencies are heavily explored in the context of cross-curricular issues like Sustainable Development and Education for Sustainable Development (ESD). Competency development appears to be more of a continuous learning process, hence opportunities for systematic and comprehensive competency development must be offered not just once, but also in subsequent courses throughout the entire education of future teachers at universities and other settings. In order to assist the development of ESD-specific abilities in teacher education learning formats that facilitate authentic and task-oriented contact, real-world problems, and the challenges of engaging partners in practice are also required (Brandt, J. O., et al., 2019).

Figure 9.
ESD in relation to teaching and learning practices
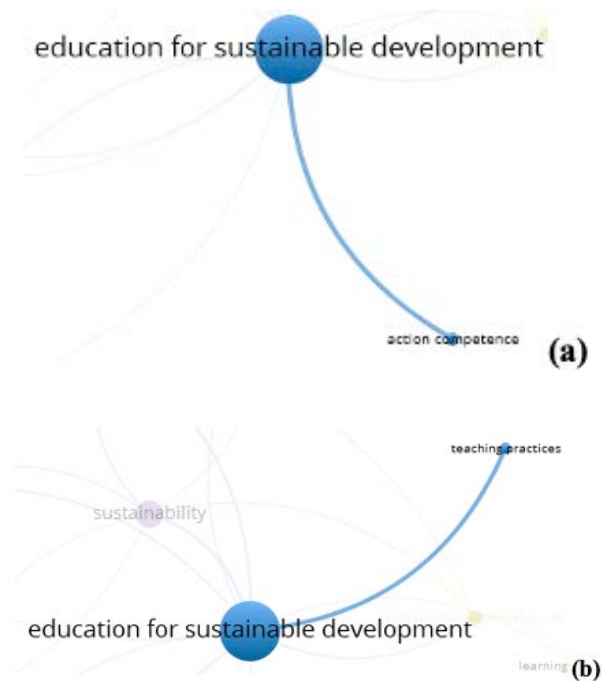
Different from clusters one and two, in cluster 3 there are two keywords, namely 'action competence' and 'teaching practices'. Even though both are in one cluster, it turns out that the two were not related to each other. However, each was directly related to ESD. This can be seen in Figure 9. Action competence and teaching practices were grouped into one cluster on the basis of learning and teaching in practice.

According to Mogensen and Schneack (2010), action competence—or "Bildung" in German—is the guiding principle of education, and the idea of "action" serves as the foundation for action competence. When examining ESD from an action competency perspective, education should come first. Furthermore, this strategy interprets "competence" considerably differently than that associated with the individualistic paradigm of human resource management. The OEC and the DeSeCo (Definition and Selection of Competency) perspective, which Development promotes, as well as the subject-focused ideas of competency, have some similarities and distinctions, though.

The action competency approach's quality standards are as follows: they emphasize better teaching and learning, reflect the democratic values that ESD aspires to advance, collaborate with key stakeholders, and support institutional and individual learning. As a result, this strategy offers an illustration from a pedagogical standpoint.

Specialized training is required for ESD-focused instruction, particularly to comprehend the ESD idea itself. Even though most teachers do not comprehend ESD, they acknowledge employing participatory approaches when teaching, according to a study (Anyolo, E. O., et al., 2018). However, in the real world, professors exclusively employ lectures, question-and-answer sessions, presentations, and lectures. Although this cannot be applied generally, it does highlight how crucial it is for teachers to socialize ESD. Therefore, research on ESD and teaching practices is gaining momentum and becoming a global issue.

Figure 10.
*ESD in relation to competency outcomes*

Figure 10 presents the relationship in cluster four which consists of learning outcomes and sustainability competencies. Unlike keywords in cluster three, the keywords in cluster four were related to each other and were directly related to ESD. Both were classified in one cluster on the basis of achievement or competence in sustainable teaching.

"Education for Sustainable Development" appears to have had a big influence on learning results. According to the United Nations Conference on Environment and Development (1992), one of the objectives of Agenda 21 is to alter people's attitudes and character in addition to creating values, attitudes, and behaviors that are compatible with sustainable

development. Significant affective outcomes are part of the "education for sustainable development" goal, which higher education institutions find challenging to meet. This group also includes learning outcomes because they are a fascinating subject. It is expected that each student would develop the attitudes, feelings, and motivations required to shape their conduct and allow them to become environmentally conscious "actors" in line with the goal of "education for sustainable development."

Figure 11.
ESD in relation to the evaluation
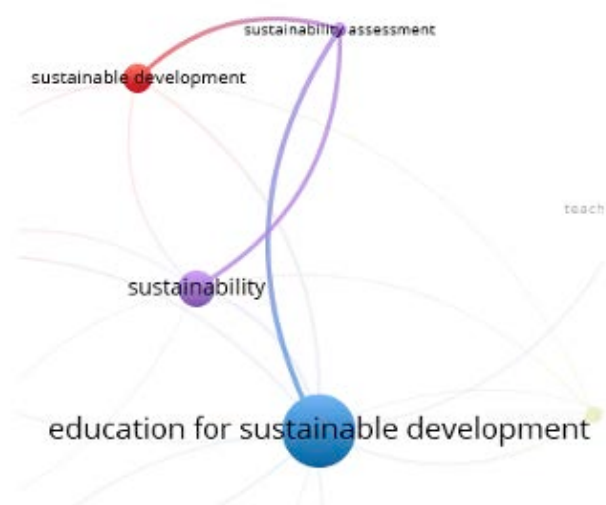
Finally, Figure 11 presents the relationship between the keywords 'sustainability' and 'sustainable assessment'. Both of these keywords were directly related to ESD. However, it can be seen that the sustainability assessment was also related to sustainable development. It can be concluded that cluster five was grouped based on the sustainable evaluation.

The majority of indicators and assessment questions in education were related to the curriculum and the availability of courses on sustainability, but Yarime, M. and Tanaka, Y. (2012) found that sustainability is more than just a topic to be added to an already overloaded curriculum. Additionally, sustainability can provide access to various viewpoints on organizational change, teaching, policy, and particularly the philosophy of continuous assessment.

In conclusion, several studies on ESD have been conducted. However, several studies focus on, among others, instrument development (Widodo, A., et al., 2023), exploration of sustainable development competencies in certain disciplines (Fröberg, A., et al., 2022), pilot studies (Eichinger, M ., et al., 2022), socialization of TPACK-ESD (Purwianingsih, W., et al., 2022), analysis of the process of integration of ESD in various fields of education (Singer-Brodowski, M., et al., 2019), ESD in higher education (Singer-Brodowski, M., et al., 2022; Birdman, J., et al., 2022; Heinrichs, H., 2021; Weiss, M., et al., 2021; Busquets, P., et al., 2021; Sánchez-

Carracedo, F., & López, D., 2021; Sánchez-Carracedo, F., et al., 2021; Sánchez-Carracedo, F., et al., 2021; Finnveden, G., et al., 2020; Muñoz-Rodríguez, J. M., et al., 2020; Duarte, A. J., et al., 2019; Westermark, Å., & Jansund, B., 2019; Sundermann, A., & Fischer, D., 2019).

This diversity led to the current research being conducted to determine the mapping of the latest research trends in ESD through bibliometric studies and to develop the research of Hallinger, P., & Chatpinyakoop, C. (2019) with literature from 1998 to 2018 that focused solely on higher education. In simple terms, in the last five years (2019-2023), the number of ESD documents throughout the year has experienced a significant increase and was divided into five clusters.

Conclusion

Based on the findings of this analysis, it can be stated that the 2019–2023 ESD research trend is likely to continue to rise. This aligns with earlier research' findings from 1990 to 2018, which similarly tended to show a sharp rise. Due to its history of using ESD in education, Sweden has produced the most study up to present time. The following organization or institution that contributes the most documents to publications on ESD is the future institute from Germany. Gericle is the top author on ESD according to Scopus data. The trend of research on ESD produces five large clusters, namely 1) ESD in the scope of learning; 2) ESD on educational programs and policies; 3) ESD related to learning and teaching in practice; 4) ESD related to achievements or competencies in continuous learning; and 5) ESD related to sustainable evaluation.

ESD will continue to be a hot topic in international study until early 2023. Thus, by considering the clusters identified in this study, research on ESD can be further enhanced. ESD research can contribute to achieving sustainable development objectives, particularly in the area of education. A sense of concern and of responsibility for the environment can be developed as well as remedies to the problems associated with global issues by improving the number and quality of ESD research.

References

Aikens, K., McKenzie, M., & Vaughter, P. (2018). Environmental and sustainability education policy research: A systematic review of methodological and thematic trends. Environmental and Sustainability Education Policy, 265-292.

Anyolo, E. O., Kärkkäinen, S., & Keinonen, T. (2018). Implementing education for sustainable development in Namibia: School teachers' perceptions and teaching practices. v(1), 64-81.

Balsiger, J., Förster, R., Mader, C., Nagel, U., Sironi, H., Wilhelm, S., & Zimmermann, A. B. (2017). Transformative learning and education for sustainable development. *GAIA-ecological Perspectives for Science and Society, 26*(4), 357-359.

Birdman, J., Barth, M., & Lang, D. (2022). Connecting curricula and competence through student learning journeys. *Sustainability: Science, Practice and Policy, 18*(1), 560-575.

Brandt, J. O., Bürgener, L., Barth, M., & Redman, A. (2019). Becoming a competent teacher in education for sustainable development: Learning outcomes and processes in teacher education. *International Journal of Sustainability in Higher Education, 20*(4), 630-653.

Breßler, J.; Kappler, S. (2017). A Systematic Review of Education for Sustainable Development (No. 007); Chemnitz Economic Papers; Chemnitz University of Technology, Faculty of Economics and Business Administration: Chemnitz, Germany.

Briner, R., Denyer, D., 2012. Systematic Review and Evidence Synthesis as a Practice and Scholarship Tool. In: Handbook of evidence-based management: Companies, classrooms and research, pp. 112–129. https://doi.org/10.1093/oxfordhb/9780199763986.013.0007.

Boeve-de Pauw, J., & Van Petegem, P. (2011). The effect of Flemish eco-schools on student environmental knowledge, attitudes, and affect. *International Journal of Science Education, 33*(11), 1513-1538.

Boström, M., Andersson, E., Berg, M., Gustafsson, K., Gustavsson, E., Hysing, E., ... & Öhman, J. (2018). Conditions for transformative learning for sustainable development: A theoretical review and approach. *Sustainability, 10*(12), 4479.

Busquets, P., Segalas, J., Gomera, A., Antúnez, M., Ruiz-Morales, J., Albareda-Tiana, S., & Miñano, R. (2021). Sustainability education in the Spanish higher education system: Faculty practice, concerns and needs. *Sustainability, 13*(15), 8389.

Chinedu, C. C., Wan-Mohamed, W. A., & Ogbonnia, A. A. (2018). A systematic review on education for sustainable development: Enhancing TVE teacher training programme. *Journal of Technical Education and Training, 10*(1).

Duarte, A. J., Malheiro, B., Arnó, E., Perat, I., Silva, M. F., Fuentes-Durá, P., ... & Ferreira, P. (2019). Engineering education for sustainable development: the European project semester approach. *IEEE Transactions on Education, 63*(2), 108-117.

Eichinger, M., Bechtoldt, M., Bui, I. T. M., Grund, J., Keller, J., Lau, A. G., ... & Heinzel, S. (2022). Evaluating the Public Climate School—A School-Based Programme to Promote Climate Awareness and Action in Students: Protocol of a Cluster-Controlled Pilot Study. *International Journal of Environmental Research and Public Health, 19*(13), 8039.

Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact?. Scientometrics, 105, 1809-1831.

Ferreira, J. A. (2018). Unsettling orthodoxies: Education for the environment/for sustainability. In Environmental and Sustainability Education Policy (pp. 121-134). Routledge.

Finnveden, G., Friman, E., Mogren, A., Palmer, H., Sund, P., Carstedt, G., ... & Svärd, L. (2020). Evaluation of integration of sustainable development in higher education in Sweden. *International Journal of Sustainability in Higher Education, 21*(4), 685-698.

Franco, I., Saito, O., Vaughter, P., Whereat, J., Kanie, N., & Takemoto, K. (2019). Higher education for sustainable development: Actioning the global goals in policy, curriculum and practice. *Sustainability Science, 14,* 1621-1642.

Fredriksson, U., N. Kusanagi, K., Gougoulakis, P., Matsuda, Y., & Kitamura, Y. (2020). A comparative study of curriculums for education for sustainable development (ESD) in Sweden and Japan. *Sustainability, 12*(3), 1123.

Fröberg, A., Wiklander, P., & Lundvall, S. (2022). Sustainable Development Competencies among More than 1100 Certified Physical Education and Health Teachers in Sweden. *International Journal of Environmental Research and Public Health, 19*(23), 15914.

Govindan, K., Hasanagic, M., 2018. A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective. Int. J. Prod. Res. 56 (1–2), 278–311. https://doi.org/10.1080/00207543.2017.1402141.

Grosseck, G., Țîru, L. G., & Bran, R. A. (2019). Education for sustainable development: Evolution and perspectives: A bibliometric review of research, 1992–2018. *Sustainability, 11*(21), 6136.

Hallinger, P., & Chatpinyakoop, C. (2019). A bibliometric review of research on higher education for sustainable development, 1998–2018. *Sustainability, 11*(8), 2401.

Hallinger, P., & Nguyen, V. T. (2020). Mapping the landscape and structure of research on education for sustainable development: A bibliometric review. *Sustainability, 12*(5), 1947.

Hallinger, P., Wang, R., Chatpinyakoop, C., Nguyen, V. T., & Nguyen, U. P. (2020). A bibliometric review of research on simulations and serious games used in educating for sustainability, 1997–2019. Journal of Cleaner Production, 256, 120358.

Heinrichs, H. (2021). Teaching Sustainable Development in a Sensory and Artful Way—Concepts, Methods, and Examples. *Sustainability, 13*(24), 13619.

Iswari, R. D., & Utomo, S. W. (2017). Evaluasi penerapan program adiwiyata untuk membentuk perilaku peduli lingkungan di kalangan siswa (Kasus: SMA Negeri 9 Tangerang Selatan dan MA Negeri 1 Serpong). *Jurnal Ilmu Lingkungan, 15*(1), 35-41.

Jickling, B., & Wals, A. E. (2012). Debating education for sustainable development 20 years after Rio: A conversation between Bob Jickling and Arjen Wals. *Journal of Education for Sustainable Development, 6*(1), 49-57.

Kemdikbud. (2021). Lokakarya Nasional Inisiatif Indonesia Menuju Pendidikan Berkelanjutan (ESD) tahun 2030. https://www.kemdikbud. go.id/main/blog/2021/04/lokakarya- nasional-inisiatif-indonesia-menuju-pendidikan-berkelanjutan-esd-tahun-2030. Diakses 18 April 2023.

Kioupi, V., & Voulvoulis, N. (2019). Education for sustainable development: A systemic framework for connecting the SDGs to educational outcomes. *Sustainability, 11*(21), 6104.

Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., & Zeng, X. J. (2018). A bibliometric analysis and visualization of medical big data research. *Sustainability, 10*(1), 166.

Lozano, R., Ceulemans, K., Alonso-Almeida, M., Huisingh, D., Lozano, F. J., Waas, T., ... & Hugé, J. (2015). A review of commitment and implementation of sustainable development in higher education: results from a worldwide survey. *Journal of cleaner production,* 108, 1-18.

Mathiyazhagan, K., Rajak, S., Sampurna Panigrahi, S., Agarwal, V., Manani, D., 2021. Reverse supply chain management in manufacturing industry: a systematic review. Int. J. Prod. Perform. *Manage. 70* (4), 859–892. https://doi.org/10.1108/IJPPM-06- 2019-0293

Mogensen, F., & Schnack, K. (2010). The action competence approach and the 'new'discourses of education for sustainable development, competence and quality criteria. *Environmental education research, 16*(1), 59-74.

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: a comparative analysis. *Scientometrics, 106*, 213-228.

Muñoz-Rodríguez, J. M., Sánchez-Carracedo, F., Barrón-Ruiz, Á., & Serrate-González, S. (2020). Are we training in sustainability in higher education? Case study: Education degrees at the University of Salamanca. *Sustainability, 12*(11), 4421.

Pavlova, M. (2013). Towards using transformative education as a benchmark for clarifying differences and similarities between environmental education and education for sustainable development. *Environmental Education Research, 19*(5), 656-672.

Prieto-Jiménez, E., López-Catalán, L., López-Catalán, B., & Domínguez-Fernández, G. (2021). Sustainable development goals and education: A bibliometric mapping analysis. *Sustainability, 13*(4), 2126.

Purwianingsih, W., Novidsa, I., & Riandi, R. (2022). Program for Integrating Education for Sustainable Development (ESD) into Prospective Biology Teachers' Technological Pedagogical Content Knowledge (TPACK). *Jurnal Pendidikan IPA Indonesia, 11*(2).

Redman, E., & Larson, K. (2011). Educating for sustainability: Competencies & practices for transformative action.

Rickinson, M., & Lundholm, C. (2008). Exploring students' learning challenges in environmental education. *Cambridge Journal of Education, 38*(3), 341-353.

Salas-Zapata, W. A., Ríos-Osorio, L. A., & Cardona-Arias, J. A. (2018). Knowledge, attitudes and practices of sustainability: Systematic review 1990–2016. *Journal of Teacher Education for Sustainability, 20*(1), 46-63.

Sánchez-Carracedo, F., & López, D. (2021). A Service-Learning Based Computers Reuse Program. *Sustainability, 13(*14), 7785.

Sánchez-Carracedo, F., Moreno-Pino, F. M., Romero-Portillo, D., & Sureda, B. (2021). Education for sustainable development in Spanish university education degrees. *Sustainability, 13*(3), 1467.

Sánchez-Carracedo, F., Ruiz-Morales, J., Valderrama-Hernández, R., Muñoz-Rodríguez, J. M., & Gomera, A. (2021). Analysis of the presence of sustainability in Higher Education Degrees of the Spanish university system. *Studies in Higher Education, 46*(2), 300-317.

Scott, W. (2014). Education for sustainable development (ESD): A critical review of concept, potential and risk. Schooling for sustainable development in Europe: Concepts, policies and educational experiences at the end of the UN Decade of Education for Sustainable Development, 47-70.

Singer-Brodowski, M., Etzkorn, N., & Von Seggern, J. (2019). One transformation path does not fit all—insights into the diffusion processes of education for sustainable development in different educational areas in Germany. *Sustainability, 11*(1), 269.

Singer-Brodowski, M., Förster, R., Eschenbacher, S., Biberhofer, P., & Getzin, S. (2022). Facing crises of unsustainability: Creating and holding safe enough spaces for transformative learning in higher education for sustainable development. In Frontiers in Education (p. 81). Frontiers.

Skolverket (2011b). Curriculum, Compulsory school, Preschool class, Recreation centre, In English. Skolverket. https://www.skolverket.se/publikationer?id=2687

Spínola, H. (2015). Environmental literacy comparison between students taught in Eco-schools and ordinary schools in the Madeira Island region of Portugal. *Science Education International, 26*, 392-413.

Stanitsas, M., Vareilles, É., Kirytopoulos, K., & Aldanondo, M. (2018, June). Sustainable development in serious games: rethinking game-based learning strategies for master's degree engineers. In MOSIM'18-12ème Conférence internationale de Modélisation, Optimisation et SIMulation (pp. 8-p).

Sundermann, A., & Fischer, D. (2019). How does sustainability become professionally relevant? Exploring the role of sustainability conceptions in first year students. *Sustainability, 11*(19), 5155.

Suprastowo, P. (2010). Kebijakan dan Implementasi Pendidikan untuk Pembangunan Berkelanjutan (Education for Sustainable Development/ESD). Kebijakan dan Implementasi Pendidikan untuk Pembangunan Berkelanjutan (Education for Sustainable Development/ESD).

Swedish National Agency for Education. (2013). Curriculum for the upper secondary school.

Taimur, S., & Sattar, H. (2020). Education for sustainable development and critical thinking competency. *Quality education*, 238-248.

UNESCO. (2023). What you need to know about education for sustainable development. https://www.unesco.org/en/education-sustainable-development/need-know. Diakses 17 April 2023.

UNESCO. (2003). Conférence générale. December 200

UNESCO. United Nations Decade of Education for Sustainable Development (2005–2014). International Implementation Scheme. 2005. Available online: http://unesdoc.unesco.org/images/0014/001486/148654e.pdf

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2014). UNESCO roadmap for implementing the global action programme on education for sustainable development. https://unesdoc.unesco.org/ark:/48223/pf0000230514

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2017). Education for sustainable development goals: Learning objectives. http://unesdoc.unesco.org/images/0024/002474/247444e.pdf

United Nations Conference on Environment and Development. 1992. Agenda 21 Chapter 36. Accessed July 5, 2023. http://www.un-documents.net/a21-36.htm

UNESCO. (2004). International implementation scheme, United Nations decade of education for sustainable development. 2005-2014. UNESCO. www.unesco.org/education

Veiga Ávila, L., Rossato Facco, A. L., Bento, M. H. D. S., Arigony, M. M., Obregon, S. L., & Trevisan, M. (2018). Sustainability and education for sustainability: An analysis of publications from the last decade. *Environmental Quality Management, 27*(3), 107-118.

Velazquez, L., Munguia, N., & Sanchez, M. (2005). Deterring sustainability in higher education institutions: An appraisal of the factors which influence sustainability in higher education institutions. I*nternational Journal of Sustainability in Higher Education, 6*(4), 383-391.

Velazquez, L., Munguia, N., Platt, A., & Taddei, J. (2006). Sustainable university: what can be the matter?. *Journal of cleaner production, 14*(9-11), 810-819.

Vilmala, B. K., Karniawati, I., Suhandi, A., Permanasari, A., & Khumalo, M. (2022). A Literature Review of Education for Sustainable Development (ESD) in Science Learning: What, Why, and How. *Journal of Natural Science and Integration, 5*(1), 35-44.

Wang, W. (2015). An exploration of patterns in the practice of education for sustainable development in China: experience and reflection. *Open Journal of Social Sciences, 3*(05), 64.

Wals, A. E., & Lenglet, F. (2016). Sustainability citizens: Collaborative and disruptive social learning. In Sustainability citizenship in cities (pp. 52-66). Routledge.

Weiss, M., Barth, M., & von Wehrden, H. (2021). The patterns of curriculum change processes that embed sustainability in higher education institutions. *Sustainability Science, 16*(5), 1579-1593.

Westermark, Å., & Jansund, B. (2019). Learning experiences from a time-geographic approach—Commodity chains, globalization, everyday life, and sustainability in context. *Journal of Geography in Higher Education, 43*(4), 486-504.

Widodo, A., Kaniawati, I., & Fujii, H. (2023). The Development and Validation of an Instrument for Assessing Science Teacher Competency to Teach ESD. *Sustainability, 15*(4), 3276.

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: a reference framework for academic program development. *Sustainability science, 6*, 203-218.

Wright, T., & Pullen, S. (2007). Examining the literature: A bibliometric study of ESD journal articles in the Education Resources Information Center Database. *Journal of Education for Sustainable Development, 1*(1), 77-90.

Yarime, M., & Tanaka, Y. (2012). The issues and methodologies in sustainability assessment tools for higher education institutions: a review of recent trends and future challenges. *Journal of Education for Sustainable development, 6*(1), 63-77.