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Sustainable Development Goals and Education: A Bibliometric Mapping Analysis

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Abstract: The 2030 Sustainable Development Agenda sets out 17 Sustainable Development Goals (SDGs) aimed at improving life in all its dimensions, covering all sectors, with a particular emphasis on education. The study presented here focuses on universities as priority organisations and agents of change within the sphere of their social commitment. We thus conducted an analysis of the related scientific production as well as a bibliometric mapping, identifying the main publications indexed in the Web of Science, within its main collection. Focusing on scientific production, we examine the types of documents published, the evolution of the number of publications, the countries of origin of the publications, the most cited sources and articles, together with the most productive authors and a co-citation analysis. Regarding the bibliometric mapping analysis, the five core clusters included in the study were: SDGs in general; SDG 4 on Quality Education; Education for Sustainable Development; Higher Education; and Education Management. Among the main conclusions reached, we would emphasise the need for a change in role and function of university education to tackle sustainable development.

Keywords: sustainable development goals; education; sustainable development; higher education; education management

1. Introduction

The concept of sustainability has undergone notable developments over the past few years. In its beginnings, the report "Our Common Future" [1] drew attention to the danger of unchecked growth, capable of depleting the planet's resources, where sustainable growth was synonymous with and linked to environmental balance. In this regard, it is necessary to consider the link between sustainability and the depletion of the planet's resources, the food crisis, excessive consumption, focusing particularly on the need to prioritize sustainability, growth and economic development [2]. To this end, it is becoming essential to conserve natural resources [3] through a process of integration. In this way, Pierri [4] identified three directions: the conservationist ecological current, or strong sustainability; the moderate environmentalist, or weak sustainability; and the critical humanistic current, which would give rise to the ecological society [5]. Over the following decade, this concept, tied in with globalisation, led scientists to develop a clear understanding that the problem and its solution should be addressed in an interdisciplinary, transversal and holistic way, and that it could not be confined exclusively to the environmental sphere. Within this framework, the Rio de Janeiro Conference on the Environment and Sustainable Development (1992) [6] raised the need to integrate education into this broader concept [7,8], but not just any type of education; instead, it emphasised the need for critical education to create awareness and commitment [9,10], as we will see later [11]. This has led to the addition of further dimensions to the concept of sustainability [9]. Along these lines, Mendoza-Cavazos [12]

states that it should be conceptualised as the field where sustainable economic growth and climate preservation interrelate, in equilibrium. It is also linked to welfare and social justice, as well as equity in different areas [13], including health, education, management, energy, agriculture, environmental issues [14], and gender [15]. Similarly, sustainable development must be taken into consideration in the business sphere, through corporate social responsibility [16–18], and by exploring how to better build students' competences in Sustainable Development [19,20], in order to consolidate significant change and innovations [21] in the short and long term [22]. Finally, it is completed with the educational dimension to achieve a full concept of sustainability [23,24].

Within the framework of globalisation, with the arrival of the Millennium Development Goals formulated by the UN in 2000, sustainability was established as one of the key objectives. However, in 2015, realising that the desired impact was not being achieved, it was decided that sustainability should occupy a central position and the Sustainable Development Goals (SDGs) were set out [6]. This reformulation gave a more holistic dimension to global development, closely linked to sustainability within the 2030 Agenda framework.

From that moment on, sustainability became firmly established, including all the dimensions exposed above and emphasising their necessary convergence: environmental issues converged with care for the environment; economic questions, with sustainable and balanced growth; and the importance of achieving social well-being, with the awareness and commitment of critical citizens, including the most vulnerable groups, achieving greater equity, justice and quality of life for all citizens [25].

Hence, based on the studies conducted [8,23], we are beginning to understand sustainability within a global, interdisciplinary, and multi-faceted dimension, focusing on life and its values [26], embracing all its dimensions in order to ensure that the world we inhabit achieves, as the ultimate priority, greater social welfare in an inclusive way for all.

This concept, of a more interrelated and holistic nature, has given rise to the notion of a "need for great transformations", that would be radical and on a vast scale, taking into account environmental, economic, and socio-educational factors, among others, in an interactive way [27].

In view of this multidimensional approach to sustainability, and in order to bring its problems and solutions into focus from this perspective, we believe that the priority strategy for achieving all the others lies in an inclusive, critical education channelled through SDG 4 [28]: Quality Education. Specifically, we centre on goal 4.7, which establishes the need to educate students in basic theoretical and practical concepts to promote sustainable development and sustainable lifestyles. To do so, three essential factors must be addressed: infrastructure (goal 4.7.a), scholarships (goal 4.7.b) and teacher qualification (goal 4.7.c) [29]. Education must be highlighted as a key instrument to accomplish the full concept of sustainability [30] by drawing attention to the relationship between sustainability, citizen participation [31] and social responsibility [17,25].

In this context, different authors have emphasised the strategic importance of universities as the main agents of change [32], responsible for training leaders [33] and teachers, and their repercussions and great impact on citizens [34–38].

Universities are, therefore, key social institutions for achieving sustainable growth. Evidence of this includes the University Leaders for a Sustainable Future association, established in 2015, and the major role of cooperation between institutions [39] in this field, generating networks and clusters such as sustainable campuses [40] or macro-campuses [41].

Also worthy of note is the relevant inclusion of principles of sustainability in University study programmes [42], creating so-called sustainable thinking [43], as well as responsibility and social commitment. Together, they draw a multidisciplinary vision of these three dimensions (sustainable growth and climate, economy, and society), based on the understanding that at all times, they are part of society; alliances, dialogue and accountability must be established with other specialised institutions [44], taking into account the defence of human rights [45].

The latter must become a major goal for universities—in their role of educational institutions—and their leaders; universities must become a priority organisation to consolidate this concept and its application to the management and training model of universities [46].

Along these lines, Cebrían [47] clarifies the need to change the culture of higher education institutions, in order to achieve sustainable universities as advocated by classical authors such as Schein [48,49], and applied to this field of sustainable organizations [50]. Key to this is the development of transferrable innovative experiences and the group's acceptance to apply this innovation. This change must arise from within the university institution itself [51]. To change roles and structures, four phases are necessary [41]: a change of vision, a change of mission, the creation of committees, and sustainable tactical strategies.

Despite this, an awareness must be raised of the difficulty of implementing such change, considering that external factors can cause the change to be delayed, as stated in the theory of post-factuality [52]. A clear example of this would be the current situation of necessary adaptation, derived from the measures required to tackle the COVID-19 crisis. The connections between these dimensions (sustainability, SDGs, education, and university) together with the time that has passed since the SDGs were proclaimed, suggest the need to understand what the interest of the scientific community is for sustainability and the SDGs, from the field of education in general. In short, a state of the art related to SDGs and sustainability in educational literature seems necessary.

Recent studies have approached the general subject of sustainable education based on bibliometric analyses [53,54] and others address the issue focusing on more concrete aspects, such as higher education [55]. These studies, however, do not shed light on whether relevant scientific publications are generating new knowledge, nor the key research areas and emerging trends that SDGs contribute to the topic.

In view of this situation, we decided to conduct an analysis of the scientific production and a bibliometric mapping to study existing publications on the SDGs, linked to the importance of education as a tool for developing and enhancing sustainability as an integrated factor [54]. Hence, the aim of this work was to analyse the lines of research present in the scientific literature on sustainability, from the point of view of education and based on the impact of Sustainable Development Goals. This will serve to guide future research lines around this new concept of sustainability, its relationship with education, and the key role of universities [20].

To that end, we structured this paper in four parts. This first section provides an introduction, positioning the authors' theoretical approach to the study of sustainability, education and the SDGs. The second section below describes the methodology followed in the bibliometric study. We will then present the results of the work. Finally, in the last section, we set out the conclusions of the study shedding light on the data provided by the analysis as well as future lines of research.

2. Materials and Methods

To analyse the existence of documents around the Sustainable Development Goals in the scientific literature in Education produced since 2015, we conducted an analysis of scientific production and a bibliometric mapping. The analysis collates indicators and also uses science mapping to provide a visual representation of the topics and their interrelationships in the object of study. Science mapping is a graphic representation of how knowledge areas, documents or authors are interrelated [56], exploring the impact of a topic, a group of researchers, or a particular piece of work [57]. Moreover, Cobo et al. [58] point out that science mapping analysis is used to show and uncover the hidden key elements in a specific interest area. This justifies our choice of methodology, since the objective of the present study was to identify, analyse and assess the recent current that gives relevance to SDGs, within a research line that has been more extensively addressed
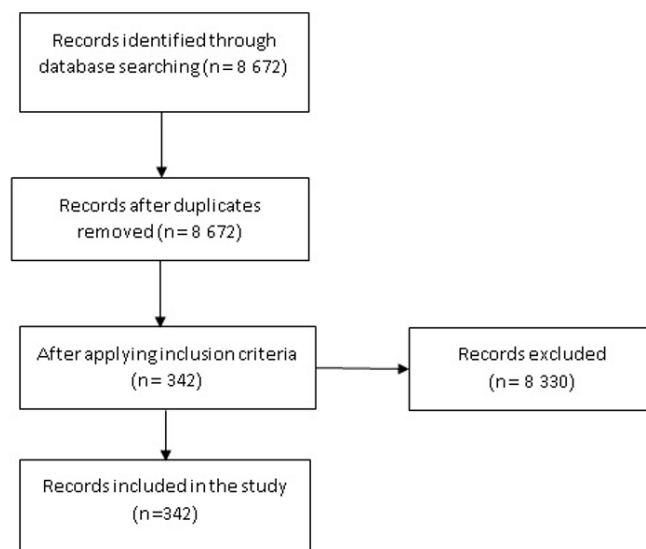
in the literature. Science mapping offers insights into patterns of knowledge accumulation that would be difficult to 'see' using traditional research review methods [55].

We used Vosviewer 1.6.15 software. The Vosviewer software has been accepted in studies that have been published in renowned journals across a range of disciplines [59,60]. It was selected for the remarkable visualisation feature it offers [61] and because it can be launched directly from the web.

To provide a rigorous analysis, we explain below each step followed during the different research stages, illustrated in Table 1 and Scheme 1 following the indications of Börner et al. [62] and Cobo et al. [58].

Table 1. Methodology.

Data Search	**Web of Science (WoS), Core Collection 2015–2020** **Search Equation (Criteria: Keywords): "Sustainable Development Goals" OR SDG OR "Sustainable Development Objectives" OR "2030 Agenda"** **Inclusion Criteria:** **Topic Category: Education & Educational Research** **Publication Years: 2015–2020**
Data refinement and normalization **Creation of the network**	Data refinement of duplicate and misspelled data Network creation: co-ocurrence and cocitation
Map Creation	Implementation of a clustering algorithm to obtain the map stage
Analysis and visualisation	Identification of the research themes

Scheme 1. Biblio metric analysis.

In the first stage, a search was performed on 23rd September 2020, as shown in Table 1. For the selection of the articles, WoS was chosen over other more recent academic platforms such as Dimensions (created in 2018), which are less time-tested and more focused on improving the search experience, and which have not implemented traditional, advanced query-based capabilities [63]. The main reason for selecting WoS is that it only incorporates the journals with the highest standards [64], which means it is effective at finding most of the relevant results [65]. The second reason is that it provides exhaustive coverage of the social sciences literature [66]. Though Scopus could now be considered for coverage, WoS offers the additional option of Keywords Plus TM, an algorithm that selects the words that frequently appear in the titles of the cited documents [67]. Furthermore, WoS, in combination with INCITES, allows the identification of works that deal with the theme category Education & Educational Research, even when published in journals classified

under other disciplines. The terms were the result of a consensus between three university experts and two professional experts in the field of Education and Sustainable Development Goals. This was extremely important, as Keywords was the field criteria (Table 1). The SDGs were approved by the United Nations general assembly in September 2015. They specify actions to achieve sustainable development, and the work analyses in what extent these objectives contribute to scientific knowledge in the field of education. That is why the strategy was to limit the search to the period starting from that year onwards. The 8672 results initially obtained were transferred to InCites, filtering by the thematic category Education & Educational Research of the Web of Science schema through InCites, obtaining 342 records. Although the international language of science is English, some bibliometric studies have pointed to the focus on English language documents as a limitation [54]. To somewhat avoid this situation, all languages were included in the search.

Secondly, the records were checked for debugging using Microsoft Excel. No duplicate records were found. Subsequently, the keywords were normalized, unifying synonyms, eliminating duplicities, and developing acronyms, after which the initial 1359 terms were reduced to 1210. For this purpose, the usual keywords (words that authors choose as most representative of their work) were included along with those assigned by the Web of Science using Keyword Plus TM (terms generated by a Thomson Reuters algorithm that selects the words that frequently appear in the titles of the cited documents) [67].

Third, keyword co-occurrence was selected, as well as the networks of keywords that correspond to research problems of significant interest [44,68]. Co-occurrence analysis allows us to measure the number of citations in which several terms appear together, supporting the identification of Thematic Currents. From this list, using the Vosviewer 1.6.15 tool, all the descriptors that appeared on at least five occasions were selected, reducing the number to 70.

After this step, the fourth phase began, during which the maps were created. Based on cluster analysis, the VOS mapping technique [69–71] was carried out. As a result, the map graphically represents the different clusters based on science mapping [64]. These maps are interpreted as research themes by the authors, depending on the generated weights and score attributes and the works assigned to each cluster.

3. Results

The results obtained derived from two types of analyses: scientific production and bibliometric mapping.

3.1. Scientific Production Analysis

The annual growth in publications over this period followed an upward trend, as shown in the graph below, except in 2020. It should be noted; however, that the end parameter for the search was September 2020.

According to the types of documents identified, 77.12% were scientific articles; 19.6% proceedings, and 8.5% book chapters (see Figure 1). The rest corresponded to early access, material editorial reviews, and books.

Regarding the location of the scientific production during the 6 years analysed by country or region of origin (see Figure 2), 50 countries from all continents were represented. England was the most prolific country, accounting for 16.5% of studies (56), followed by the United States and Spain, which represented 14% (48 studies) and 13.8% (47 studies), respectively. Finally, Australia accounted for 6.1% (21) of the scientific production, followed by Canada 5.5% (19).
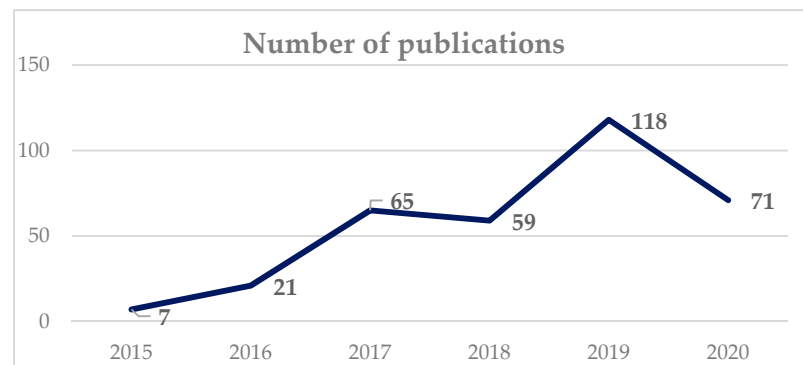
Figure 1. Evolution of the number of publications in recent years.
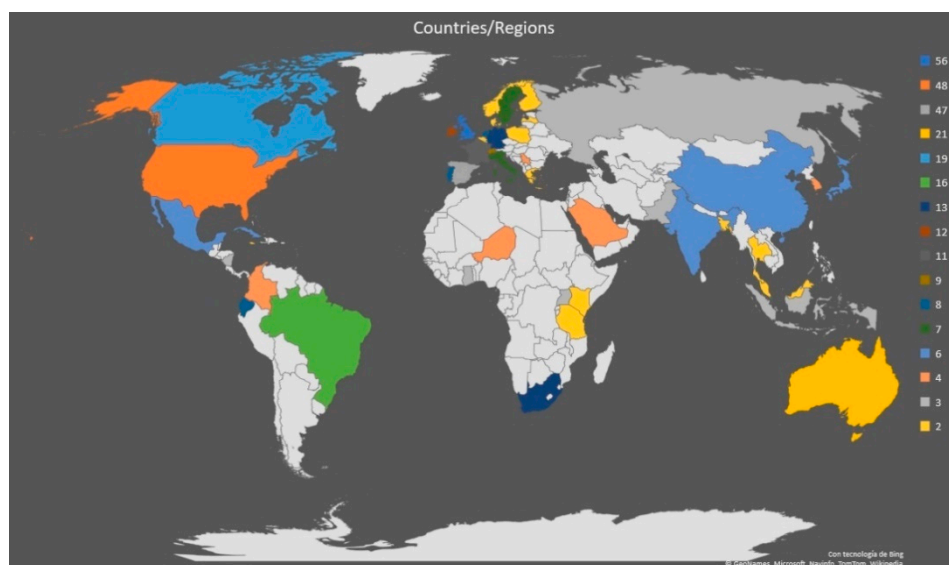
Figure 2. Location map of the scientific production.

The authors of the identified publications came from 82 different organisations, thus indicating extensive interest and widely dispersed scientific production. During the period under review, the University College of London (UCL), UNESCO and the University of Edinburgh each published seven papers, followed by the Universidad de Valencia, with six papers. The third place was shared by Curtin University, the Spanish universities Universitat Jaume I and the Universidad de Salamanca, and the University of South Africa. The latter published five studies on the topic, analysed between 2015 and September 2020.

The Web of Science thematic categories into which these publications are classified (see Table 2), mainly cover the fields of education, green sustainable science technology, management and business studies. The first category, which was present in 99.7% of the documents analysed, is of particular relevance.

Within this category, the main sources included in the records analysed—the subject of which includes SDGs and belong to the Education Educational Research category—are represented in Table 3. The most relevant papers based on the number of citations received are shown in Table 4.

Table 2. Thematic categories of the publications analysed.

Web of Science Categories	Records	% of 341
Education Educational Research	340	99.70
Green Sustainable Science Technology	42	12.31
Management	32	9.38
Business	27	7.91
Environmental Studies	10	2.93
Education Scientific Disciplines	7	2.05
Regional Urban Planning	6	1.76
Area Studies	5	1.46
Political Science	5	1.46
Psychology Educational	5	1.46
Social Sciences Interdisciplinary	3	0.88

Table 3. Ranking of the 10 sources that contain the analysed records.

No.	Source Titles	Records	% of 341	JCR Impact Factor	SJR Impact Factor
1	International Journal of Sustainability in Higher Education	28	8.21	2.000	0.64
2	International Journal of Management Education	27	7.91	2.354	0.76
3	International Review of Education	18	5.27	-	0.39
4	Edulearn Proceedings	17	4.98	-	-
5	Policy Practice A Development Education Review	14	4.10	-	-
6	Inted Proceedings	12	3.51	-	-
7	Edulearn19 11th International Conference on Education and New Learning Technologies	10	2.93	-	-
8	Iceri Proceedings	10	2.93	-	-
9	World Sustainability Series	10	2.93	-	-
10	Revista Internacional de Educacion para la Justicia Social	8	2.34	-	-

As can be seen in Table 3, among the top ten journals that address the subject under study, those that are directly related to Higher Education top the list. Journals with more general topics on education and sustainable development come next. In this latter case, it is worth nothing that both number 4, as well as 6 and 8, are proceedings of scientific events that took place. This leads us to reflect on the relevance of the object of study as the scientific community seems to address these study dimensions by sharing experiences and disseminating them to the rest of the scientific and educational community.

One can observe in Table 4 how a majority of the most cited publications focus on identifying what the University should do to respond to the demands of the SDGs (numbers 6, 7, 8, 9). In this sense, publications 1, 3, 4 and 5 go one step further by identifying strategies and methodologies consistent with this objective, publication 2 being the one that focuses on the importance of attending to University Social Responsibility. Finally, publication 10 centres on showing possible difficulties when evaluating the degree of Development of the SDGs in a University setting, given that it constitutes a complex dimension to measure.

Having established the most cited publications in the field, the most productive authors are represented below, as in the previous sections (Table 5).

Table 4. Ranking of the 10 most cited documents.

No.	Title	Authors	Source Title	Year	Total Citations
1	Interdisciplinary: Practical approach to advancing education for sustainability and for the Sustainable Development Goals	Annan-Diab, Fatima; Molinari, Carolina	International Journal of Management Education	2017	58
2	Responsible management education: Mapping the field in the context of the SDGs	Storey, Meredith; Killian, Sheila; O'Regan, Philip	International Journal of Management Education	2017	32
3	Implementing the sustainable development goals at University level	Albareda-Tiana, Silvia; Vidal-Ramentol, Salvador; Fernandez-Morilla, Monica	International Journal of Sustainability in Higher Education	2018	27
4	Seeking learning outcomes appropriate for 'education for sustainable development' and for higher education	Shephard, Kerry; Harraway, John; Lovelock, Brent; Mirosa, Miranda; Skeaff, Sheila; Slooten, Liz; Strack, Mick; Furnari, Mary; Jowett, Tim; Deaker, Lynley	Assessment & Evaluation in Higher Education	2015	25
5	Implementing sustainability as the new normal: Responsible management education—From a private business school's perspective	Kolb, Monika; Froehlich, Lisa; Schmidpeter, Rene	International Journal of Management Education	2017	24
6	Universities and the post-2015 development agenda: an analytical framework	McCowan, Tristan	Higher Education	2016	23
7	Higher education in the sustainable development goals framework	Owens, Taya Louise	European Journal of Education	2017	22
8	From challenge to opportunity—Management education's crucial role in sustainability and the Sustainable Development Goals - An overview and framework	Weybrecht, Giselle	International Journal of Management Education	2017	20
9	'Beyond 2015', within the modern/colonial global imaginary? Global development and higher education	Stein, Sharon; Andreotti, Vanessa de Oliveira; Susa, Rene	Critical Studies in Education	2019	19
10	Negative capability? Measuring the unmeasurable in education	Unterhalter, Elaine	Comparative Education	2017	19

3.2. Bibliometric Mapping

Having examined the scientific production, we focused on co-citation analysis and the use of algorithms to obtain the science maps and its clusters. Co-citation analysis involves tracking pairs of papers that are cited together in the source articles. When the same pairs of papers are co-cited by many authors, clusters of research begin to form. The co-cited papers in these clusters tend to share some common themes [52].

The co-citation analysis (a co-citation link is a link between two items that are both cited by the same document) was performed, taking into account the journals and the media mentioned above, based on the criterion that they were cited at least 20 times; from there we selected the 10 most cited, as in the previous cases (Table 6).

Table 5. Ranking of the 10 authors who contributed the most publications.

| No.	Authors	Institution	Country	Records	% of 341
1	Koehn Ph	University of Montana	USA	5	1.46
2	Uitto Ji	Global Environment Facility	USA	5	1.46
3	Andre M	Leeds Beckett University	UK	3	0.88
4	Arruda Nd	Instituto Superior de Administração e Economia—ISAE	Brazil	3	0.88
5	Campbell Ac	Middlebury Institute of International Studies at Monterey	USA	3	0.88
6	King K	University of Edinburgh	UK	3	0.88
7	Kopnina H	The Hague University of Applied Sciences	The Netherlands	3	0.88
8	Latchem C	University of Oldenburg	Germany	3	0.88
9	Mccloskey S	Centre for Global Education	UK	3	0.88
10	Mccowan T	Institute of Education, University College London	UK	3	0.88

Table 6. Ranking of the 10 journals or media with the highest co-citation index.

No.	Source	Citations	Total Link Strength
1	Journal of Cleaner Production	248	3026
2	International Journal of Sustainability in Higher Education	155	2251
3	International Journal of Educational Development	151	1548
4	Environmental Education Research	122	1387
5	Thesis	118	823
6	The International Journal of Management Education	86	735
7	Computers & Education	68	714
8	Compare	68	642
9	International Journal of Sustainability	66	1180
10	Sustainability	62	993

Finally, and concluding the scientific production analysis, the 10 most cited authors (see Table 7) showed that international organisations occupied the main positions. The relationship between these authors via co-citation is illustrated in Figure 3.

**Table 7.** Ranking of the 10 most prolific authors in co-citation.

No.	Author	Citations	Total Link Strength
1	UNESCO	479	1654
2	United Nations	196	880
3	OECD	96	459
4	World Bank	56	324
5	Kopnina, H.	51	175
6	Lozano, R.	46	292
7	Freire, P.	37	151
8	Leal Filho, W.	37	238
9	UNICEF	36	120
10	Barth, M.	31	213
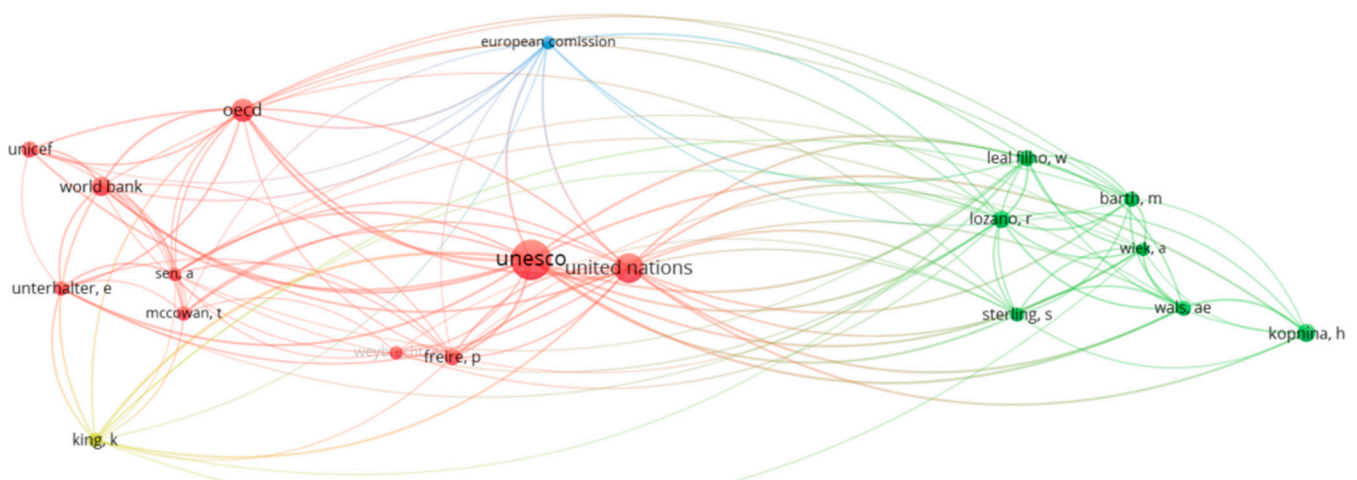
Figure 3. Overview of the most prolific authors in co-citation.

The results obtained from the cluster analysis carried out with Vosviewer 1.6.15. facilitated the identification of five clusters based on the 70 terms presenting an occurrence greater than 5. These clusters reflect the lines or strands of research pursued by the papers analysed.

- Cluster 1: Sustainable Development Goals.
- Cluster 2: SDG 4, on Quality Education.
- Cluster 3: Education for Sustainable Development.
- Cluster 4: Higher Education.
- Cluster 5: Sustainability and principles for responsible management in education and firms.

The following image (Figure 4) provides an overview of the interrelationship of these five clusters and the general themes that link to each of them:
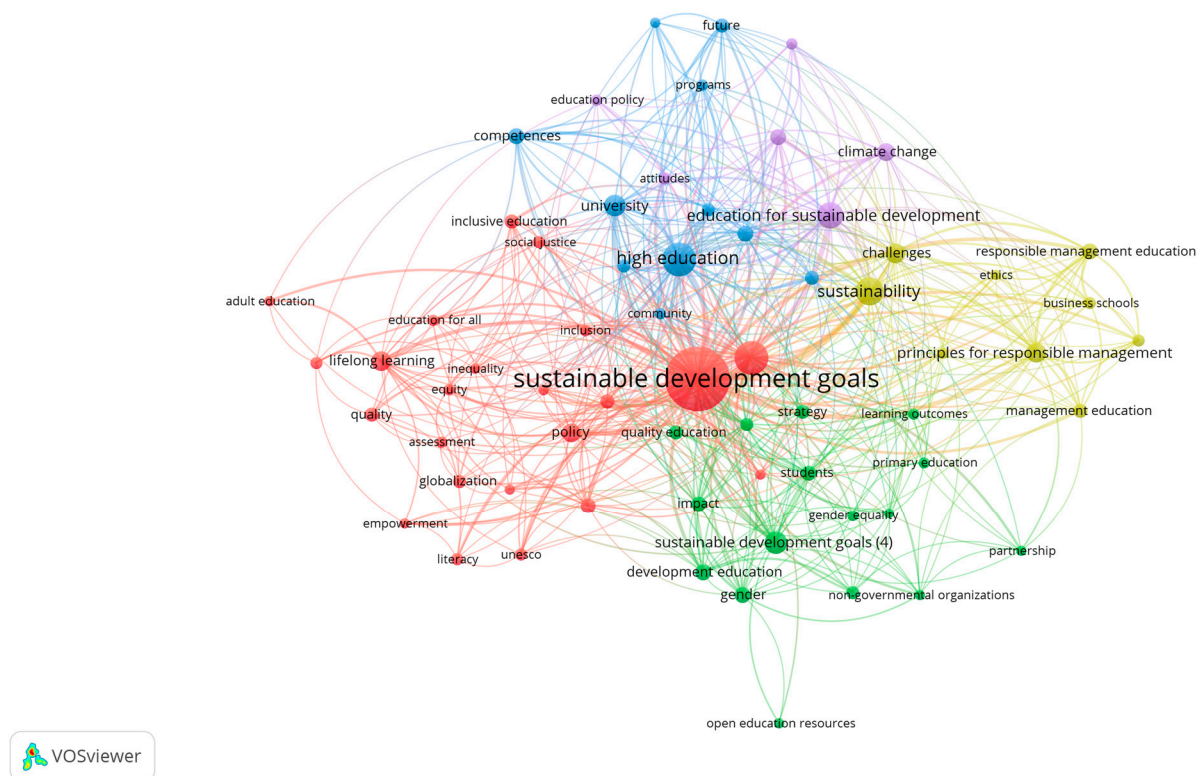
Figure 4. Overview of the five clusters analysed.

In the network visualization, items (keywords in our case) are represented by their label and, by default, also by a circle. The size of the label and the circle of an item is determined by the weight of the item. The higher the weight of an item, the larger the label and the circle of the keyword. The colour of an item is determined by the cluster to which the item belongs [71].

Following this general overview of the study, we will now analyse each one in more detail.

3.2.1. Analysis of Cluster 1: Sustainable Development Goals in General

This cluster includes papers that address the Sustainable Development Goals in a general way. In particular, the articles address this subject from the point of view of education [72], the policies and measures that lead to them [73], and those related to human rights [74].

The following table (Table 8) presents the data obtained following the analysis of cluster 1, which shows the eight most frequently used labels, as well as their weight.

Table 8. Quantitative analysis of Cluster 1.

Label	Weight <Links>	Weight <Total Link Strength>	Weight <Occurrences>
Sustainable development goals	64	415	183
Education	46	128	51
Lifelong learning	24	50	17
Policy	29	50	16
Millennium development goals	18	33	10
Human rights	12	33	9
Inclusive education	12	22	9
Quality	11	15	9

Within the field of education, one of the most identified strategies in these studies for achieving SDGs was lifelong learning [73]. Lovren and Popovic [75] defend the need to create an area for policies that consider adult education from the perspective of sustainability. These papers also analyse the recommended policies at a theoretical level, the legal barriers [76], and the impact of reforms in relation to human rights [77]. In these studies, education appears to be a catalyst for human rights [78,79]. Finally, it is interesting to note the presence of empirical evidence on the way in which SDGs are approached in countries such as Nigeria [80], Ghana [81], and Spain [82], among others. Internationally, Schuelka and Lapham [83] conducted a comparative analysis of inclusive education as part of the SDGs (SDG 3) and the Convention on the Rights of Persons with Disabilities (2006).

3.2.2. Analysis of Cluster 2: Sustainable Development Goal 4

The second cluster includes papers related to SDG number 4. This SDG promotes: Guaranteeing an inclusive, fair and quality education, and promoting opportunities for lifelong learning for all. Around this fundamental objective, we find papers that combine themes related to development education, gender, students, impact, strategy, quality education, as well as those dealing with global citizenship education. (See Table 9).

Table 9. Quantitative analysis of Cluster 2.

Label	Weight <Links>	Weight <Total Link Strength>	Weight <Occurrences>
Sustainable Development Goals (4)	29	49	22
Development Education	18	33	12
Gender	21	32	12
Students	19	29	10
Impact	19	27	10
Strategy	12	21	9
Quality education	12	19	9
Global Citizenship Education	10	17	8

In this sense, some studies measured the impact of development education on students [84] or make very specific contributions to quality education by proposing a code of good practice in development education [85]. Del Cerro Velazquez and Lozano Rivas [86] make a methodological contribution to the achievement of SDG 4 in secondary schools in STEM subjects. Also included in this group are analyses of experiences in which strategies were implemented on the ground with a gender focus [87], again offering concrete pedagogical guidelines that would facilitate the achievement of SDG 4.

Finally, particularly salient is how the role of global citizenship as an agent of education and promoter of the SDGs is legitimised in Noh [88], through the dissemination of values such as responsibility or respect for differences. In this regard, a certain number of analyses of urban strategies highlight the importance of coordination and networks among citizens together with proposals for educational intervention that support and address sustainable development objectives [89].

3.2.3. Analysis of Cluster 3: Education for Sustainable Development

This cluster encompasses clearly defined papers with Education for Sustainable Development as a contribution to the SDGs [90]. On this subject, the papers tackle various aspects such as climate change, environmental education, attitudes needed to address sustainable education, policies or the role of the community in sustainable education. (See Table 10)

Table 10. Quantitative analysis of Cluster 3.

Label	Weight \<Links\>	Weight \<Total Link Strength\>	Weight \<Occurrences\>
Education for sustainable development	38	97	30
Climate change	18	37	14
Environmental education	18	37	12
Attitudes	11	18	7
Education policy	10	14	6
Sustainability education	10	17	6

With an integrating approach to sustainability and education, educational policies on sustainability are reflected in studies such as Beveridge et al. [91], which analyses the initiatives developed by Canadian ministries of education and their materialisation in schools.

Thus, some studies analyse the aspects needed for a transformative education on climate change and the formative role of education for sustainable development in the climate change agenda [92]. They also highlight the need to address attitudes and the consideration of specific phenomena—such as plant blindness in Amprazis and Papadopoulou [93]—as a barrier to achieving the SDGs.

3.2.4. Analysis of Cluster 4: Higher Education

This cluster groups articles that focused especially on higher education. Throughout this article, this level of education has been identified as key to addressing the SDGs, so let us examine the data in this regard. (See Table 11)

Table 11. Quantitative analysis of Cluster 4.

Label	Weight \<Links\>	Weight \<Total Link Strength\>	Weight \<Occurrences\>
High education	39	128	50
University	26	63	21
Competences	18	34	12
Curriculum	27	47	12
Future	16	34	9
Innovation	19	36	9
Science	22	27	8
Teachers	18	26	8

As we can see, they treat the SDGs as a context for the proposed analyses [94]. Some papers present universities as driving forces for development and analyse the challenges faced by universities to make sustainable development a reality [95], highlighting innovation [96], among other aspects. The acquisition of competences in sustainability is indicated as a necessary commitment of universities [97], and some studies also analyse the integration of sustainable development in the curriculum of higher studies, calling on teachers to adopt an interdisciplinary perspective [98].

Figure 4 clearly illustrates the above, identifying innovation and change as the direct allies of the university institution, within the framework of the SDGs, to achieve development education and sustainable institutions.

3.2.5. Analysis of Cluster 5: Sustainability and Principles for Management Education

Cluster 5 encompasses articles that address sustainability through management education (Table 12). They present the crucial role of management education in achieving the SDGs [99].

Table 12. Quantitative analysis of Cluster 5.

Label	Weight <Links>	Weight <Total Link Strength>	Weight <Occurrences>
Sustainability	36	97	35
Principles for responsible management education	25	72	18
Challenges	35	74	17
Responsible management education	15	46	11
Management education	16	28	9
Business schools	13	27	7
Principles	12	25	7
Values	14	20	6
Ethics	9	17	5

Within this group, several closely interrelated lines were identified. These papers were related to the topic of responsible management education (RME) or focused on analysing the principles of responsible management education. Covering both aspects, Storey et al. [22] compile initiatives in this field, and Arruda [100] proposes a transdisciplinary methodology designed by a business school to integrate Principles of Responsible Marketing Management Education (PRME) into school curricula. Some articles also address management education in general and other studies examine in greater depth how business schools implement the figure of the Responsible Managing Employee (RME) [101] and the challenges and values to be assumed for sustainability.

4. Discussion

The scientific production included in the WoS over the last 5 years has substantially increased, being more prolific in recent years. Nevertheless, a decline is evident in the year 2020. We relate this drop directly to the closing date of the present publication (September 2020) as well as the influence of COVID-19, which may have led to reduced scientific productivity and is reflected in the smaller number of publications. Altogether, we cab observe a growing interest in the scientific community in research and publications on the SDGs. This production, although well distributed across all continents, originates mainly in the UK, USA and Spain.

We should also highlight the level of involvement of large international organisations that appear to be linked to the origin of the publications (82). In addition, five of them (UNESCO, UN, OECD, WB and UNICEF) feature in the ranking of the ten most prolific authors in terms of co-citation. In this regard, we believe that sustainable development has been established as the framework of action of many international bodies, providing an impetus to the general public and academic circles [102]. As proof of this, in 2005, UNESCO declared 2010–2020 to be the Decade of Education for Sustainable Development. It attached particular importance to the training of university students as future leaders and, therefore, to the importance of universities as role models for social organisations.

Along these lines, and based on the results obtained from clusters 4 and 5, we can say that the greatest concern regarding publications related to higher education and educational management revolves around the acquisition and development of competences, as well as reviewing the curriculum, teacher qualifications, and the need for change through innovation [8,30,31,103].

With regard to training and education, we analysed clusters 2 and 3, addressing Quality Education (directly related to SDG 4), as well as Education for Sustainable Development. In this case, it should be noted that the vast majority of studies published on Education for Sustainable Development were directly linked to more environmental and climate-related dimensions; whereas in the case of Quality Education, identified in cluster 2, it takes on a more multidimensional and multifaceted nature, addressing issues of gender, student, impact, strategy, quality and global citizenship education, all focused on sustainable development, underscoring the importance of embracing different dimensions when referring

to the topic [11,25,45,104,105]. Along the same lines, Shane and Venkataraman [106] highlight the need to transform the educational system and incorporate a systemic view of sustainability in education and society.

Finally, as a frame of reference, we analysed existing SDG publications globally. There, we found greater production linked to Education and Lifelong Learning, related at all times to Human Rights, Inclusion and Quality [37,46,57,103–105,107].

5. Conclusions

The aim we set ourselves in carrying out this work was to analyse the lines of research related to sustainability, from the point of view of education, at an international level, in the field of the Sustainable Development Goals (SDGs). With this study, we were able to see the direct link between sustainable development, quality education, university, and university management.

Initially, we saw how the concept of sustainability shifted from a simple approach to fighting for the climate, to striking a balance with sustainable growth, to the incorporation of human rights as a priority within this new concept. This political dimension led us to integrate the environmental, economic and social dimension into sustainable development, along the lines of equity, gender, justice, and social welfare. This eagerly awaited quality of life is directly linked to quality education [8,30,31,36,108]. Despite the need to address sustainable development incorporating all these dimensions [12], we identified in the study how the dimension of sustainable development continues to be related more directly to the climate and the environment.

Worthy of note, this issue is still in the hands of international organizations, and less so in those of researchers. Thus, among the 10 authors who have written the most on this subject, 5 are international organizations. Focusing on the field of Higher Education, the subject is still identified as specific topic, instead of being considered a transversal aspect linking specific dimensions of sustainable development to competencies across the curriculum, and far from being understood as the axis of the necessary change in the university.

Education's link and relevance to sustainability is clear, as seen in SDG 4, although by analysing the results of the study, we understand that there is still a long way to go to achieve the desired quality. Proof of this is that education 4.0 responds more to the development of digital and technological competences, leaving behind key aspects of the contributions that might generate a more critical, inclusive perspective concerned with the most vulnerable groups [11,25,45,103,105].

Universities have become strategic actors with respect to the development of sustainability [109]. With this purpose, and focusing on quality education in universities, as educational and training centres for educators, they require a change of role, structure, and leadership in accordance with new demands; otherwise, their level of commitment and social responsibility will not respond to the new demands of sustainability [27,30,31,34,35].

Given this new panorama, universities must adapt to the changes required by the environment; they must become more adaptable and enterprising in order to remain up to date [99]. Universities are in need for a review and renewal process that will turn them into direct agents of change, confirming their commitment to sustainable development [50,109,110]. We believe that this change should revolve around the three core strands to approach them as organisations [37,41,111]:

- The plan should re-examine the mission, vision, strategies, and tactics of universities within a holistic, integrated, and interactive framework of sustainability in the three dimensions: Environmental, Economic, and Social. This will promote inclusion, equality and social welfare, as well as quality of life.
- They need to switch to more flexible and open structures that allow for the integration of processes, their interrelationship, and ease of application to curricula with compulsory core transversal competences in all their academic offering, based on sustainability.

- The third element relates to university leadership and management, necessitating a change in culture, wherein sustainability is the axis of all processes of research, training, as well as evaluation and the identification of good practices. Along these lines, although a wide range of proposals exists regarding key processes of change for universities, there is a lack of experience and concrete measures to make that change viable and valid.

In addition to this lack of concrete experiences that would provide us with strategies for success, there is the additional challenge, denounced by some authors such as Bohne [36], that, despite declarations, meetings, conventions and signatures, there is a clear lack of political will to address and implement them within the framework of the 2030 Agenda for Sustainability and the SDGs. Likewise, the appearance of COVID-19 will change economic and social priorities, but it will also lead to a major line of research and publications [112].

In conclusion, we consider that this new concept of more multifaceted, multidimensional, and interdisciplinary sustainability has demonstrated the need for change, not only in the role of universities but also in their structure, forcing them to take organisational decisions within the framework of their social responsibility [36,47,109] and making a commitment to pursuing a balance between sustainable economic growth and the preservation of the environment and climate [24], all in line with the defence of human rights, equity, social welfare, and quality of life, grounded in the key reference of providing an education and training in critical citizenship and allowing students to become agents of change [54,103,105,113,114]. We believe this education will deliver quality by considering and promoting the inclusion of the most vulnerable groups and through the use of ICTs via social media [46]. However, this reality will not be viable if the implementation is not accompanied by a participatory and open process that involves the whole university community [115].

We believe that very few publications and research papers have addressed this global dimension of sustainability so far. In addition, we must factor in the aspects derived from COVID-19, such as the growth of technological, educational and social divides [116], which directly affect the SDGs generally, and SDG 4 in particular [28,29,43,115].

To affirm that a University is educating towards sustainability, it must coordinate the evaluation processes that help to understand whether students have developed such competencies, whether in their formative or professional Development [117]. For this, clear assessment indicators and criteria must be defined that will help to identify the extent of the incorporation and commitment of universities in sustainable development and the SDGs [118].

As a final reflection, regarding the study's limitations, we must signal that the methodological process addressed in this study [54] has led to results of a rather quantitative nature. For this reason, future publications should adopt a more qualitative approach, going more in depth in each of the articles indicated in the analysis, in order to analyse the variables that relate them. Similarly, it would be of interest to extend this study to the SCOPUS database. Moreover, due to the choice of the WoS as a source, the article selection may have been subject to an English language bias. Therefore, it would be relevant that future studies use other sources, which, though less prestigious, would represent a broader range of publications in other languages. Finally, another limitation was the 5-year period of the study, which might have affected the production and exploitation of the data. Nevertheless, with 2015 being the year that the Sustainable Development Goals were enunciated, we did not dispose of a longer study period. Therefore, the present work should be understood as an initial analysis, with the hope that it will be completed with other articles covering a longer temporal vision.

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