ISSN: 2584-0231(Online)
International Journal of Multidisciplinary Research in Arts, Science and Technology
© IJMRAST | Vol. 3 | Issue 8 | August 2025
Available online at: https://ijmrast.com
DOI: https://doi.org/10.61778/ijmrast.v3i8.160

GLOBAL RESEARCH TRENDS IN SUSTAINABLE DEVELOPMENT GOAL 4: A BIBLIOMETRIC ANALYSIS OF SCIENTIFIC PUBLICATIONS USING SCOPUS DATABASE (2015-2024)

Muhammad Faiz[1*], Muhammad Fawwaz Muhammad Yusoff[2]

[1]Doctoral Candidate, Universiti Sains Islam Malaysia, Bandar Baru Nilai, 71800 Nilai, Negeri Sembilan

[2]Associate Professor, Universiti Sains Islam Malaysia, Bandar Baru Nilai, 71800 Nilai, Negeri Sembilan

[*]**Corresponding Author Email Id:** almafaaz15@gmail.com

ABSTRACT

The United Nations (UN) Sustainable Development Goals (SDGs) encompassing 17 goals, adopted in 2015, are a universal call to address pressing global issues. The SDG 4 that aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all", acts as a crucial catalyst to facilitating the other 16 SDGs. This study investigates global research trends related to SDG 4, spanning from 2015 to 2024. Using a bibliometric analysis based on data from the Scopus database, it examines the evolution, publication growth, and thematic focuses of SDG 4-related research. The study highlights the multidimensional approach of SDG 4, emphasizing the interconnected principles of inclusion, equity, quality education, and lifelong learning, which collectively address global educational challenges. It identifies significant contributions from developed countries while noting the increasing participation of developing nations. The analysis also underscores the role of collaborative international efforts in advancing research and implementation strategies. Key themes like inclusive education and lifelong learning dominate scholarly discourse, reflecting their alignment with global sustainability goals. The findings reveal a steady growth in research output, with an annual publication growth rate of 12.05%. By mapping collaborations, prominent authors, influential journals, and funding agencies, the study provides valuable insights into the dynamics of SDG 4 research. It recommends addressing critical research gaps, fostering cross-disciplinary collaboration, and ensuring equitable educational development worldwide as the 2030 Agenda progresses.

Keywords: *SDG 4 – Quality Education – Inclusive Education – Lifelong learning - Sustainable Development Goals – Agenda 2030*

1. INTRODUCTION:

The world faces urgent challenges including poverty, inequality, climate change, and social injustice. In response, the United Nations adopted the 17 Sustainable Development Goals (SDGs) with 169 targets in September 2015 as part of the 2030 Agenda for Sustainable Development, endorsed by all 193 UN member

states (United Nations, 2015). Recognizing the important role of education in sustainable development, the 2030 Agenda highlights education as a stand-alone goal (SDG 4) and includes targets on education under several other SDGs, notably those on health, growth and employment, sustainable consumption and production, and climate change (UNESCO et al., 2015).

SDG 4 holds particular significance due to its comprehensive scope, encompassing ten targets that address diverse dimensions of education (Boeren, 2019; Hanemann, 2019). Recognized as central to global well-being, it positions education—especially through target 4.7 on sustainability—as a foundation for achieving all SDGs (Giangrande et al., 2019; Kioupi & Voulvoulis, 2019; Saini et al., 2023). By promoting inclusive and equitable education within a lifelong learning framework, SDG 4 acts as a catalyst for sustainable development (Silo & Ketlhoilwe, 2020). Its emphasis goes beyond access, integrating quality, equity, diversity, and inclusion through targets such as eliminating gender disparities and ensuring opportunities for marginalized groups, including children with disabilities, indigenous peoples, and disadvantaged populations (United Nations, 2015). Inclusion entails not only equal entry but also supportive environments where learners are valued regardless of gender, ethnicity, ability, or socioeconomic background (UNESCO, 2020). Quality education under SDG 4 entails equitable outcomes that build both cognitive and non-cognitive skills, address systemic inequities, and empower learners to contribute to sustainable societies (Tonegawa, 2023; Ydo, 2022). Furthermore, lifelong learning is framed as an inclusive, transformative process ensuring continuous access to education across ages and contexts, reinforcing SDG 4's role as the driver of human and societal progress (UNESCO et al., 2015; United Nations, 2015).

To shed light on the contribution of researchers to SDG 4 literature, the current study aimed to assess research volume and research trends of scientific publications over the decade following the introduction of the 2030 Agenda (2015-2024). Recent studies have approached the general subject of sustainable education based on bibliometric analyses (Grosseck et al., 2019; Hallinger & Nguyen, 2020) and others have addressed the issue by focusing on more concrete aspects, such as higher education (Hallinger & Chatpinyakoop, 2019). These studies, however, do not shed light on whether relevant scientific publications are generating new knowledge, nor on the key research areas and emerging trends that SDGs contribute to the topic. (Prieto-Jiménez et al., 2021) analysed the lines of research present in the scientific literature on sustainability, from the perspective of education and based on the impact of SDGs. Nonetheless, this study lacks a thorough examination that emphasizes the literature on SDG 4 and its concepts. Thus, this study uses bibliometric methods to map global trends, identify prolific contributors, and analyse thematic clusters in SDG 4 research between 2015 and 2024. The study is guided by the following research questions:

- RQ1: What are the types of publications related to SDG 4?
- RQ2: What is the trend in publication growth for SDG 4 research?
- RQ3: Which key journals have made significant contributions to SDG 4?
- RQ4: What are the most highly cited publications in SDG 4 research?
- RQ5: Who are the SDG 4 top research publications' institutions, countries, and authors?
- RQ6: What are SDG 4 research publications' most prolific research subject areas?

- RQ7: What are the authors' typical keywords and themes in SDG 4 research publications?
- RQ8: Who are the prolific funders in SDG 4 research?

This study is structured into five sections: the first introduces the research and theoretical framing of SDG 4; the second outlines the methodology; the third presents the results; the fourth is the discussion; and the final section offers conclusions and recommendations for future research.

2. METHODS AND MATERIALS

2.1. Search Tool

This study conducted a descriptive analysis of scholarly literature pertaining to SDG 4, employing bibliometric analysis methods on data extracted from the Scopus database.

2.2. Search Strategy

The current study was carried out on December 15th, 2024. The Scopus database was searched using a specific search algorithm, that involved using Boolean logical search operators to find document titles related to SDG 4. The Scopus document database was quired by using the following search string:

TITLE ("SDG 4*" OR "Sustainable Development Goal 4*" OR "SDG4*" OR "SDG-4*" OR "Quality Education*" OR "Inclusive Education*" OR "Equitable Education*" OR "Lifelong learning*")

The asterisk (*) indicates any character group, including null characters. The search was limited to the period from 2015 to 2024.

2.3. Inclusion and Exclusion Criteria

The study included documents beyond those explicitly titled "SDG 4," incorporating publications with key phrases such as "quality education," "inclusive education," "equitable education," and "lifelong learning" themes central to the goals of SDG 4.

Document types analysed included articles, book chapters, conference papers, reviews, editorials, and books. Excluded materials comprised errata, letters, notes, short surveys, conference reviews, retractions, and lecture notes. Only English-language publications were considered, including both open-access and non-open-access sources, as well as articles in press. **Figure 1** presents the data filtration and screening process used in this study.

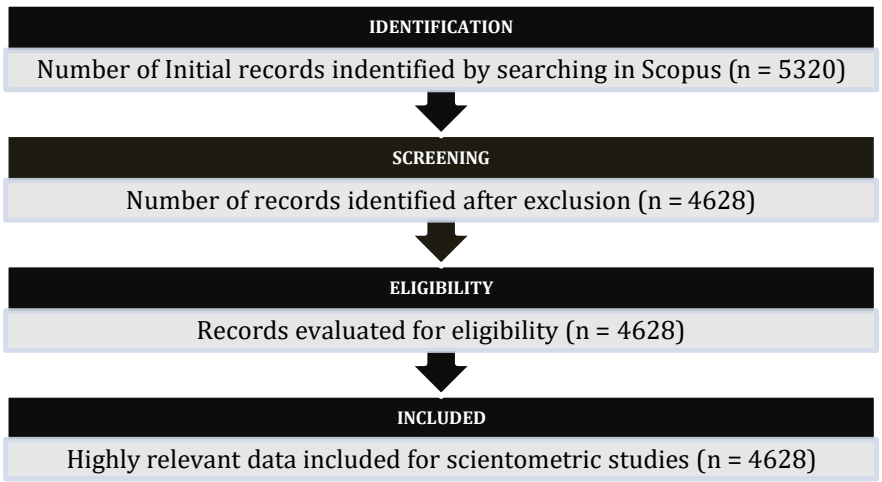

Figure 1 Data Filtration and Screening using PRISMA Flowchart

2.4. Analysis Tool

The analysis of 4,628 retrieved documents employed several statistical and bibliometric tools. Initial calculations were performed using Scopus, and data were exported in CSV format for management in Microsoft Excel 365, which supported data cleaning, filtering, and statistical analysis. To extract the data, bibliometrix R-package Biblioshiny (version 4.1.3) was used. For mapping and visualization, VOSviewer (version 1.6.18) was used. Moreover, BibExcel (version 2017) was employed for further citation analysis.

2.5. Bibliometric Mapping Methods

This study incorporated diverse bibliometric approaches to investigate multiple components, including co-authorship, co-occurrence, citation, bibliographic coupling, and co-citation analyses.

2.5.1. Co-authorship analysis

Used to visualize international collaboration, this method highlights partnerships among researchers from different countries and provides insight into the collaborative structure and disconnected clusters within SDG 4 research (Maghsoudi et al., 2023).

2.5.2. Co-occurrence analysis

Also known as co-word analysis, this technique explores the frequency and co-appearance of author keywords to identify thematic connections in the literature (Van Eck & Waltman, 2014). It assumes that frequently co-occurring terms are thematically linked (Donthu et al., 2021).

2.5.3. Citation analysis

Applied to map intellectual linkages between publications, citation analysis helps identify the most influential journals and articles in SDG 4 research. It operates on the principle that citations reflect intellectual influence (Donthu et al., 2021).

2.5.4. Bibliographic coupling

This approach was used to uncover conceptual connections among various publications focused on SDG 4 research. Bibliographic coupling is a science mapping technique that operates on the principle that two publications sharing common references are also similar in their content (Kessler, 1963; Weinberg, 1974).

2.5.5. Co-citation analysis

This technique was deployed to determine how often two SDG 4 researchers are cited together by other academics, providing insight into potential commonalities in their research interests. This is a science mapping technique that assumes that publications that are cited together frequently are similar thematically (Hjørland, 2013).

3. RESULTS

3.1. Main Information

Table 1 shows the key descriptive information for the study, encompassing the period from 2015 to 2024. The data included details on the sources, authors, and citations. The study examined 4628 documents published in 1983 sources from the Scopus database. These documents covered research on SDG 4 and

involved 10583 authors using 5936 keywords ("ID") and 8295 author-specific keywords. The study revealed an annual growth rate of 12.05 %. On average, each document received 8.277 citations, and there were 2.82 co-authors per document, with approximately 20.4 % of these co-authors being international collaborators. Of the total publications, articles represent the predominant document type, comprising 61% (2859) of the entire collection.

Table 1 Descriptive statistical information about the collection of SDG 4.

DESCRIPTION	RESULTS
MAIN INFORMATION ABOUT DATA	
Timespan	2015:2024
Sources (Journals, Books, etc.)	1983
Documents	4628
Annual Growth Rate %	12.05
Document Average Age	3.48
Average citations per doc	8.277
References	172267
DOCUMENT CONTENTS	
Keywords Plus (ID)	5936
Author's Keywords (DE)	8295
AUTHORS	
Authors	10583
Authors of single-authored docs	1047
AUTHORS COLLABORATION	
Single-authored Documents	1222
Co-Authors per Document	2.82
International co-authorships %	20.4
DOCUMENT TYPES (%)	
article	2859 (61.8%)
book	83 (1.8%)
book chapter	833 (18%)
conference paper	551 (11.9%)
editorial	124 (2.7%)
review	178 (3.8%)

3.2. Publication Growth and Citation Trend

The advent of Agenda 2030 has brought the SDGs, particularly SDG 4, into sharp focus within academic and expert circles. Researchers and specialists have conducted in-depth analyses of SDG 4's implementation across national, regional, and global contexts. Their critical findings have been disseminated through an array of scholarly publications, collectively shaping international dialogues on sustainable development.

Table 2 provides the year-wise growth rate of publications between 2015 and 2024 and their citation metrics, such as citation counts, average citations per publication, and the h-index concerning SDG 4. During this period, a total of 4268 research publications were published, depicting a significant increase in the number of publications over time and cited 38,304 times in total. With an annual growth rate of 12.05 %, the number of published research papers increased from 270 in 2015 to 752 in 2024, reflecting an increased interest and progressively more attention has been paid to SDG 4. The year 2024 published the highest number of publications, with a total of 752, followed by 2021 (TP = 727) and 2020 (TP = 598). Therefore, it is anticipated that the annual number of publications will continue to rise. The annual distribution of citation counts showed a slight fluctuating trend.

Table 2 Annual publication and citation structure of SDG 4, i.e., 2015 to 2024.

Year	TP	TC	C/P	TCP	C/CP	h-index
2015	270	3385	12.53	226	14.97	33
2016	303	3011	9.93	240	12.54	28
2017	303	4681	15.44	227	20.62	31
2018	282	4170	14.78	240	17.37	30
2019	443	7271	16.41	342	21.26	35
2020	467	6339	13.57	398	15.92	36
2021	484	4191	8.65	391	10.71	31
2022	598	2866	4.79	442	6.48	22
2023	727	1587	2.18	396	4	13
2024	752	803	1.06	242	3.31	11

TP = Total publications, TC = Total citations, C/P = Average citations per publication, TCP = Total cited publications, C/CP = Average citations per cited publication

On the other hand, 2019 received the maximum citation with a TC of 7271, as well as the highest average citations per publication, i.e., a C/P of 16.41 indicating that the average publication from that year was highly impactful. C/CP shows a similar pattern, peaking at 21.26 in 2019. The year 2020 had the maximum h-index (h-index = 36) suggesting that 2020 publications had high citation diversity. The correlation between publication volume and citation patterns is depicted in **Figure 2**, showcasing a steady upward trajectory in the number of publications from 270 in 2015 to 752 in 2024. This nearly threefold increase, with an R2 value approximating 1, signifies a growing emphasis on SDG 4-related research over the years, notwithstanding a slight dip in count during 2018. However, the R2 value for total citations exhibits inconsistency in contrast with the publication trend. Notably, the most recent years (2022-2024) tend to have lower citation scores, C/P and C/CP values, potentially signalling shorter timespans for citations to accrue or shift in research impact. Furthermore, it takes at least two years to gather substantial data for meaningful analysis.

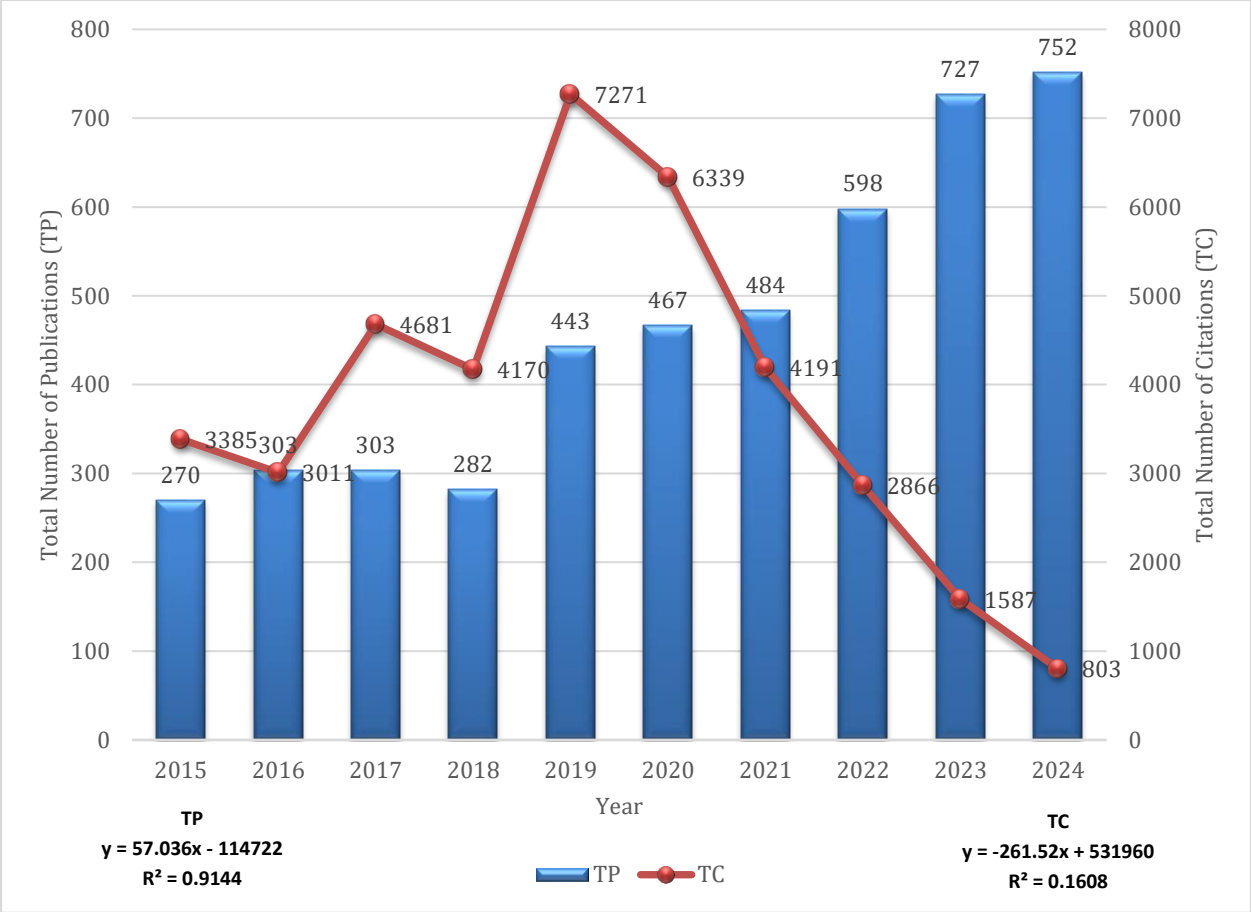

Figure 2 Publications growth and citation on SDG 4 research (2015–2024).

3.3. Highly Cited Publications

Analysing highly cited papers offers a valuable opportunity to grasp the present state of knowledge in a specific field. **Table 3** offers an in-depth analysis of the top 10 most cited publication on SDG 4 between 2015 and 2024. The table presents a comprehensive picture of the extent to which the research community recognized and cited these articles. The tabular data indicate that among the 10 most frequently cited publications, the top four accumulated an exceptional number of yearly citations, surpassing 300. Strikingly, the highest-ranked publication has amassed 1898 citations, which is almost quadruple the number received by second-place publications at 487 citations. This shows the significant impact and contribution of these articles in the field of SDG 4.

The total citation (TC) range for the top 10 publications is notably broad, spanning from 230 to 1898 citations. Such variation reflects both the diversity of research focus and the different levels of scholarly attention these works have received. Alongside TC, the table also presents normalized citations (NC), which range from 28.75 to 316.33. Unlike raw citation counts, NC provides a more balanced measure of impact by adjusting for publication year, thereby offering a clearer indication of the relative influence of each study within its contemporary research landscape. The wide NC range underscores how certain publications have attained exceptional visibility and relevance, shaping scholarly conversations on SDG 4 far beyond their immediate academic circles. In sum, the tabular information offers crucial insights into the most frequently cited works related to SDG 4, illustrating their impact on the advancement of knowledge within this domain.

Table 3 Highly cited publication of SDG 4

DOCUMENT	AUTHOR	YEAR	TC	NC
Continual lifelong learning with neural networks: A review	Parisi, G.I., Kemker, R., Part, J.L., Kanan, C., Wermter, S.	2019	1898	316.33
Efficient lifelong learning with A-GEM	Chaudhry, A., Marc'Aurelio, R., Rohrbach, M., Elhoseiny, M.	2019	487	81.16
Lifelong learning with dynamically expandable networks	Yoon, J., Yang, E., Lee, J., Hwang, S.J.	2018	437	62.42
Expert gate: Lifelong learning with a network of experts	Aljundi, R., Chakravarty, P., Tuytelaars, T.	2017	359	44.87
Education, lifelong learning, inequality and financial access: evidence from African countries	Tchamyou, V.S.	2020	275	55
Inclusive education in higher education: challenges and opportunities	Moriña, A.	2017	255	31.87
Understanding inclusive education: ideals and reality	Haug, P.	2017	254	31.75
BATCHENSEMBLE: AN ALTERNATIVE APPROACH TO EFFICIENT ENSEMBLE AND LIFELONG LEARNING	Wen, Y., Tran, D., Ba, J.	2020	241	48.2
Selective experience replay for lifelong learning	Isele, D., Cosgun, A.	2018	237	33.85
Encoder Based Lifelong Learning	Rannen, A., Aljundi, R., Blaschko, M.B., Tuytelaars, T.	2017	230	28.75

TC = Total citation of the article, NC = Normalized citation is the average number of times an article is cited per year since its publication.

To explore semantic and conceptual relationships between documents, we used bibliographic coupling, which identifies related papers based on shared references. From the original 4,628 documents, we applied a threshold of ≥50 citations to isolate the most impactful works, resulting in a final set of 84 papers. This refined network, visualized in **Figure 3**, highlights key clusters and thematic linkages within SDG 4 research.

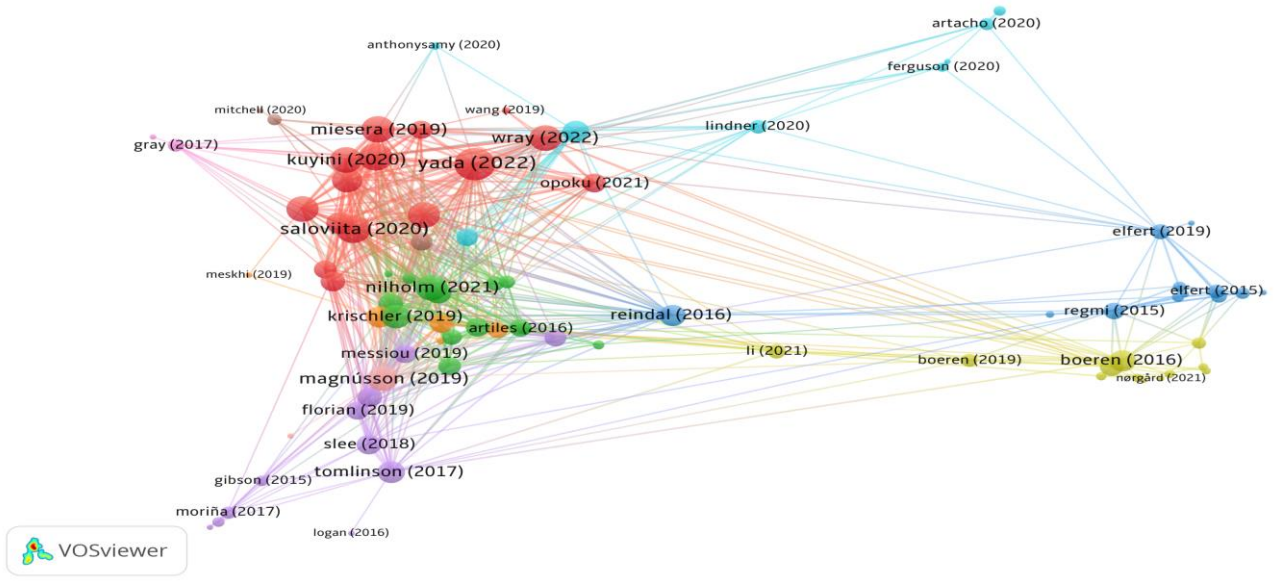

Figure 3. Bibliographic coupling of publications related to SDG 4 research

In the network, each document is represented by a node, with line thickness indicating connection strength. Node size reflects total link strength, and unique colours distinguish clusters. Ten clusters were identified, with the red cluster focusing on educators' perspectives on inclusive education. At its core is (Yada et al., 2022), with a link strength of 185 and 64 citations, followed by (Saloviita, 2020), with 124 link strength and 131 citations, and (Dignath et al., 2022), with 115 and 50 citations, respectively. These three publications are all part of the red cluster and primarily investigate educators' perspectives on inclusive education.

3.4. Productive Journals

Table 4 presents the top 10 journals publishing SDG 4-related research from 2015 to 2024. The International Journal of Inclusive Education leads with 199 articles and 3,974 citations, followed by Sustainability (Switzerland) (TP = 77; TC = 988) and the International Journal of Lifelong Education (TP = 61; TC = 493), reflecting their significant contributions to the field.

Among the journals evaluated based on their Citescore (JCS), the "International Journal of Inclusive Education" stands out as the frontrunner with an impressive score of 7.5. Close behind are two other prominent journals: "Sustainability (Switzerland)" and the "European Journal of Special Needs Education," boasting scores of 6.8 and 6.0 respectively. Regarding SJR, "European Journal Of Special Needs Education" comes in the first place with the score 1.048, followed by "Sustainability (Switzerland)" (0.828), and "International Review Of Education" (0.762) Concerning the h-index, the "International Journal of Inclusive Education" (33), and "European Journal of Special Needs Education" (20) are the most remarkable.

The data show that Taylor & Francis dominates SDG 4 publishing, with 4 of the top 10 journals, including the top-ranked International Journal of Inclusive Education. MDPI follows with two journals. This underscores the pivotal role of major publishers in advancing educational sustainability research. The findings suggest that leading SDG 4 journals are reputable and influential, shaping both academic discourse and research priorities. Additionally, the thematic focus of these journals reflects the evolving interests of contributing scholars.

Table 4 The 10 most productive journals in SDG 4 research with their most cited article

Journal	TP	TC	h-index	JCS 2023	SJR 2023	The most cited article and its citations	Publisher
International Journal Of Inclusive Education	199	3974	33	7.5	0.828	Research in the field of inclusive education: time for a rethink? (178)	Taylor & Francis
Sustainability (Switzerland)	77	988	15	6.8	0.672	Teacher training in lifelong learning-the importance of digital competence in the encouragement of teaching innovation (150)	MDPI
International Journal Of Lifelong Education	61	493	12	3.1	0.555	Lifelong learning through the SkillsFuture movement in Singapore: challenges and prospects (44)	Taylor & Francis
European Journal Of Special Needs Education	60	1340	20	6.0	1.048	Inclusive education in higher education: challenges and opportunities (255)	Taylor & Francis
Education Sciences	58	237	8	4.8	0.669	A systematic review on inclusive education of students with visual impairment (23)	MDPI
International Review Of Education	57	764	15	5.6	0.762	Understanding Sustainable Development Goal (SDG) 4 on “quality education” from micro, meso and macro perspectives (154)	Springer Nature
International Perspectives On Inclusive Education	47	175	8	1.2	0.217	ASSISTIVE TECHNOLOGY SUPPORTING INCLUSIVE EDUCATION: EXISTING AND EMERGING TRENDS (25)	Emerald Publishing
Journal Of Research In Special Educational Needs	42	431	12	3.0	0.565	Correlation between attitudes, concerns, self-efficacy and teaching intentions in inclusive education evidence from German pre-service teachers using international scales (60)	John Wiley & Sons
International Journal Of Disability Development And Education	40	407	13	3.0	0.442	Toward a Globally Sensitive Definition of Inclusive Education Based in Social Justice (41)	Taylor & Francis
Frontiers In Education	38	190	8	2.9	0.627	Attitudes Toward Inclusive Education: An Exploration of the Interaction Between Teachers’ Status and Students’ Type of Disability Within the French Context (34)	Frontiers Media S.A.

TP = Total number of publications, TC = Total number of citations, JCS (Citescore) = is a journal ranking score provided by Scopus which is based on the citation impact of the journal, SJR = Scimago Journal Rank

To better understand the intellectual structure of SDG 4 research, we used citation-based mapping to analyze inter-journal citation patterns. From an initial 1,983 journals, we applied a threshold of at least five shared documents and ten citations, yielding 98 qualifying journals. These were included in the network visualization shown in **Figure 4**

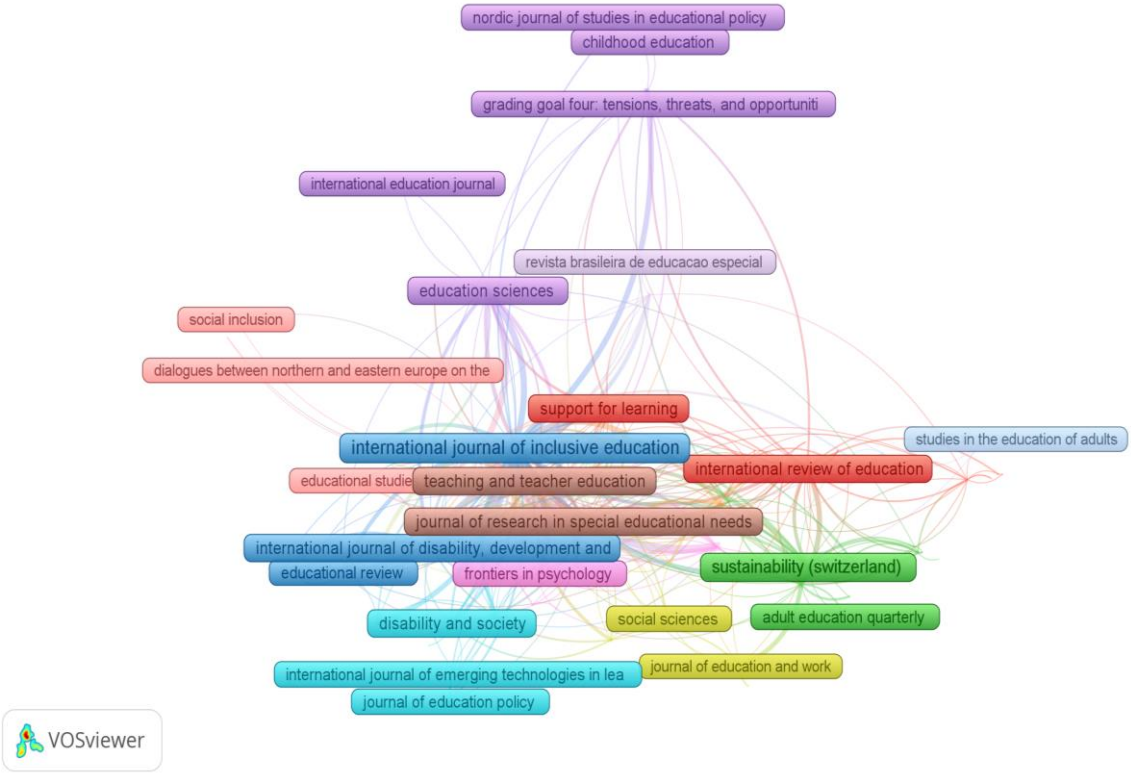

Figure 4 Bibliographic coupling of publications related to SDG 4 research

The network comprises 14 clusters, with node size indicating importance and line thickness reflecting relationships. Proximity denotes thematic similarity, while colours represent different clusters. The International Journal of Inclusive Education, the top-ranked journal, appears as the central node. Most journals listed in **Table 4** also hold prominent positions within this network.

3.5. Most Prolific Authors

Table 5 highlights the top 10 most productive authors in SDG 4 research, with publication counts ranging from 9 to 28. Sharma, U. (Monash University, Australia) leads with 28 publications and also tops citation impact with 643 citations. He is followed by Opoku, M.P. (United Arab Emirates University) with 21 publications, and Boyle, C. with 16. Asongu, S.A. and Schwab, S. each contributed 15 papers, with 495 and 454 citations, respectively. Woodcock, S. received 341 citations, further underscoring the influence of this author group.

The table also presents the h-index values of the top authors. S.A. Asongu (AGDI, Cameroon) holds the highest h-index of 63, reflecting the broad impact of his work. Notably, four authors are affiliated with Australian institutions, underscoring Australia's strong presence in SDG 4 research. Their high citation counts further demonstrate their influence in advancing this field.

Table 5 List of the 10 most prolific authors in SDG 4 research area.

Name	TP	TC	C/P	Scopus ID	H index	Affiliation	Country
Sharma, U.	28	643	22.96	14623321600	35	Monash University	Australia
Opoku, M.P.	21	251	11.95	56668689500	18	United Arab Emirates University	UAE
Boyle, C.	16	291	18.18	23481041600	24	The University of Adelaide	Australia
Asongu, S.A.	15	495	33	55489726500	63	African Governance and Development Institute (AGDI)	Cameroon
Schwab, S.	15	454	30.26	53881872700	24	Universität Wien	Austria
Carrington, S.	14	121	8.64	16232125400	25	Queensland University of Technology	Australia
Deng, M.	14	169	12.07	7202079327	14	East China Normal University	China
Walton, E.	14	219	15.64	36612533000	13	University of Nottingham	UK
Woodcock, S.	11	341	31	35794198100	19	Griffith University	Australia
Eaton, E.	9	156	17.33	12445029500	24	University of Pennsylvania	USA

TP = Total number of publications, TC = Total number of citations, C/P = Average citations per publication

To examine researcher relationships, a co-citation network was created from 962 authors with at least 30 citations. **Figure 5** visualizes these connections, illustrating how frequently authors are cited together—an indicator of thematic similarity. Based on co-citation frequency, Sharma, U., Ainscow, M., and Asongu, S.A. emerge as central figures in SDG 4 research, reflecting the significant impact of their scholarly contributions.

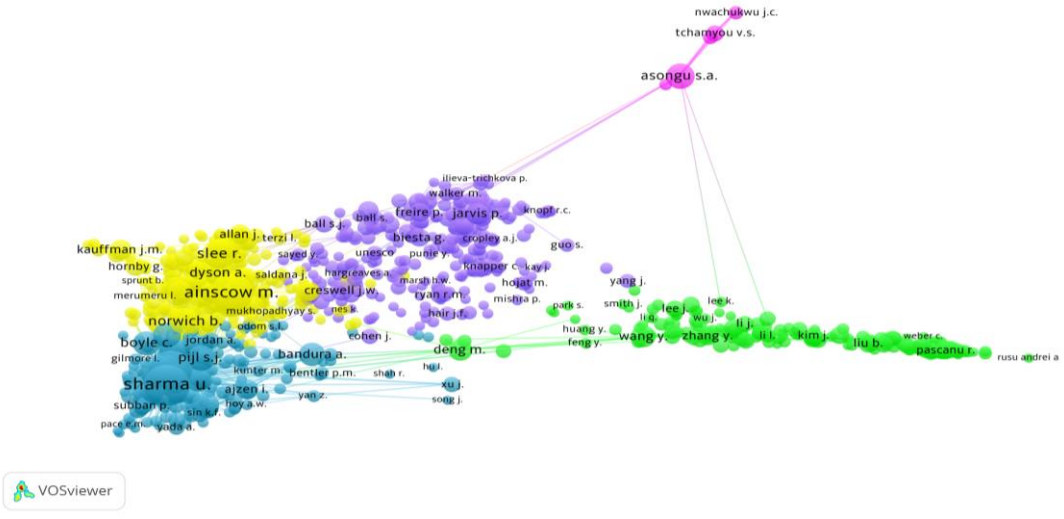

Figure 5 Co-citation network map for authors with a minimum of 30 citations.

3.6. Prolific Institutions

Table 6 Most productive institutions in SDG 4 research

Institution	Country	TP	TC	C/P	h-index	QS WUR 2025
University of South Africa	South Africa	57	709	12.43	13	851-900th
Monash University	Australia	49	830	16.93	16	37th
Queensland University of Technology	Australia	40	387	9.67	13	213th
Griffith University	Australia	36	307	8.52	9	255th
North-West University	South Africa	33	864	26.18	17	851-900th
The University of British Columbia	Canada	28	353	12.6	9	38th
University College London	United Kingdom	27	340	12.59	9	9th
University of Kansas	United States	26	661	25.42	14	452nd
The Education University of Hong Kong	China	26	253	9.73	9	20th
University of Johannesburg	South Africa	25	127	5.08	5	312th

TP = Total number of publications, TC = Total number of citations, C/P = Average citations per publication, QS WUR = The QS World University Rankings

From 2015 to 2024, institutions worldwide have actively contributed to SDG 4 research, advancing the UN's 2030 Agenda. **Table 6** lists the top 10 institutions by publication output. The University of South Africa leads with 57 publications, followed by Monash University (49) and Queensland University of Technology (40). Notably, South Africa and Australia each have three institutions in the top 10, reflecting their leadership in this field. Other represented countries include the UK, USA, Canada, and China, indicating global engagement with SDG 4 scholarship.

In citation impact, North-West University ranks first with 864 citations, followed by Monash University (830) and the University of South Africa (709). For h-index, North-West University leads with 17, followed by Monash (16) and the University of Kansas (14), reflecting strong research influence. **Figure 6** visualizes the interconnections among 60 institutions using bibliographic coupling. The network comprises seven distinct clusters, including only institutions with at least four shared documents and 10 citations.

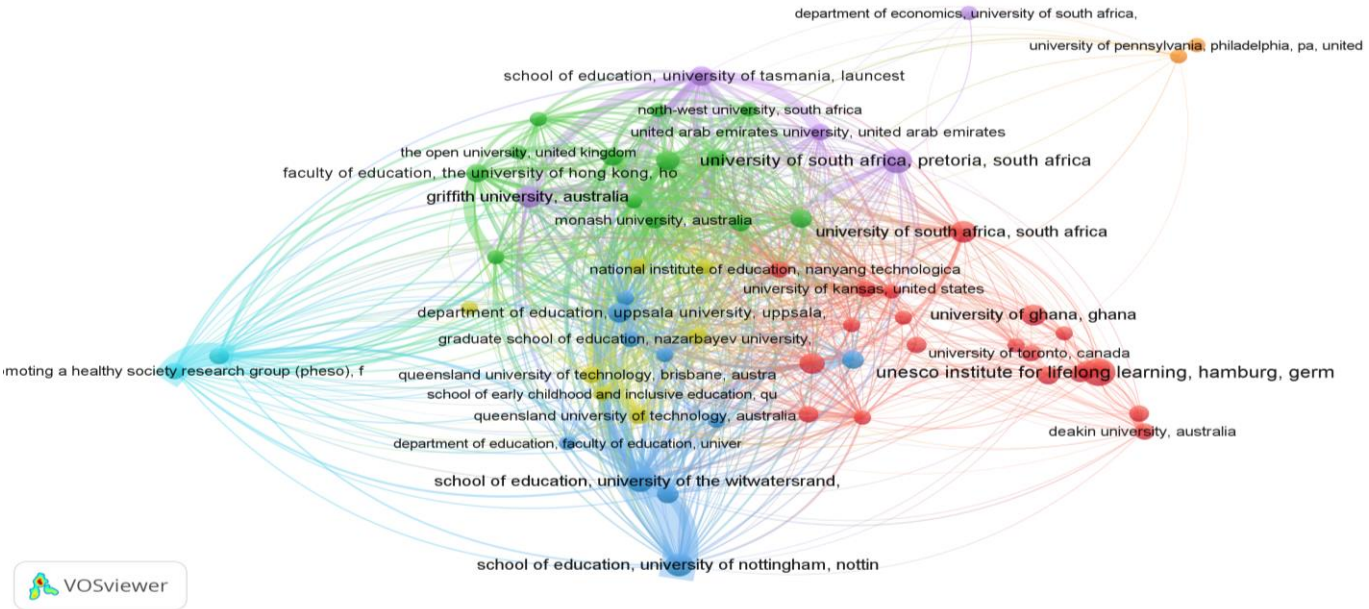

Figure 6 Bibliographic coupling of 60 institutions publishing in SDG 4

3.7. Productive Countries

SDG 4 has attracted contributions from researchers across 145 countries. **Table 7** lists the top 15 countries by total publications (TP), ranging from 93 to 659, with an average of 230. Citation counts (TC) span from 380 to 7,985, while h-index values range from 10 to 38, averaging 20.4. These figures reveal a concentration of research among a few countries, with higher publication outputs typically correlating with greater citation impact and h-index scores.

Table 7 Productive countries in SDG 4 research.

Country	Status	Continent	TP	TC	C/P	h-index
USA	G20	North America	659	7985	12.11	38
United Kingdom	G20	Europe	479	7107	14.83	33
Australia	G20	Australia	290	3254	11.22	29
Spain	EU; G20	Europe	256	2507	9.79	22
China	G20	Asia	253	1677	6.62	21
South Africa	G20	Africa	241	2617	10.85	27
Canada	G20	North America	220	2471	11.23	24
Germany	G20	Europe	209	4010	19.18	25
India	G20	Asia	158	827	5.23	15
Russia	G20	Europe - Asia	131	526	4.01	12
Italy	G20	Europe	129	640	4.96	13
Turkey	G20	Europe - Asia	119	530	4.45	11
Indonesia	G20	Asia	113	380	3.36	10
Malaysia	-	Asia	96	554	5.77	11
Sweden	EU; G20	Europe	93	1076	11.56	15

TP = Total number of publications, TC = Total number of citations, C/P = Average citations per publication

USA tops the list, with an impressive TP of 659, TC of 7985, and an h-index of 38. This indicates a substantial focus on SDG 4 research by American researchers. The United Kingdom follows closely with TP = 479, TC = 7107, and an h-index of 33, demonstrating a significant commitment to the field. Australia (TP = 290, TC = 3254 & h-index = 29), Spain (TP = 256, TC = 2507 & h-index = 22), China (TP = 253, TC = 1677 & h-index = 21), South Africa (TP = 241, TC = 2617 & h-index = 27), and Canada (TP = 220, TC = 2471 & h-index = 24) also feature prominently among the leading countries in SDG 4 research.

The high research output of the top countries reflects their economic strength, investment in science, and technological advancement. Notably, 13 of the top 15 contributors are G20 members, with strong European and Asian representation. Extensive international and institutional collaboration, supported by robust funding and research infrastructure, drives their productivity. Germany stands out with the highest citations per publication (C/P = 19.18), highlighting its impact. These findings emphasize the leading role of these nations in advancing SDG 4 research.

Collaborations between countries and institutions significantly enhance knowledge dissemination and academic exchange (Chen et al., 2020). Such partnerships, both domestic and international, improve research visibility and citation impact (Ekundayo & Okoh, 2018; Zhang et al., 2010). To explore international cooperation in SDG 4 research, we created a co-authorship network comprising 57 countries, each with at least 20 shared documents. **Figure 7** visualizes these relationships from 2015 to 2024. In the network, nodes represent countries, line thickness indicates collaboration strength, and circle size reflects the number of contributing articles. Different colours denote distinct clusters, revealing five major collaborative groups in global SDG 4 research.

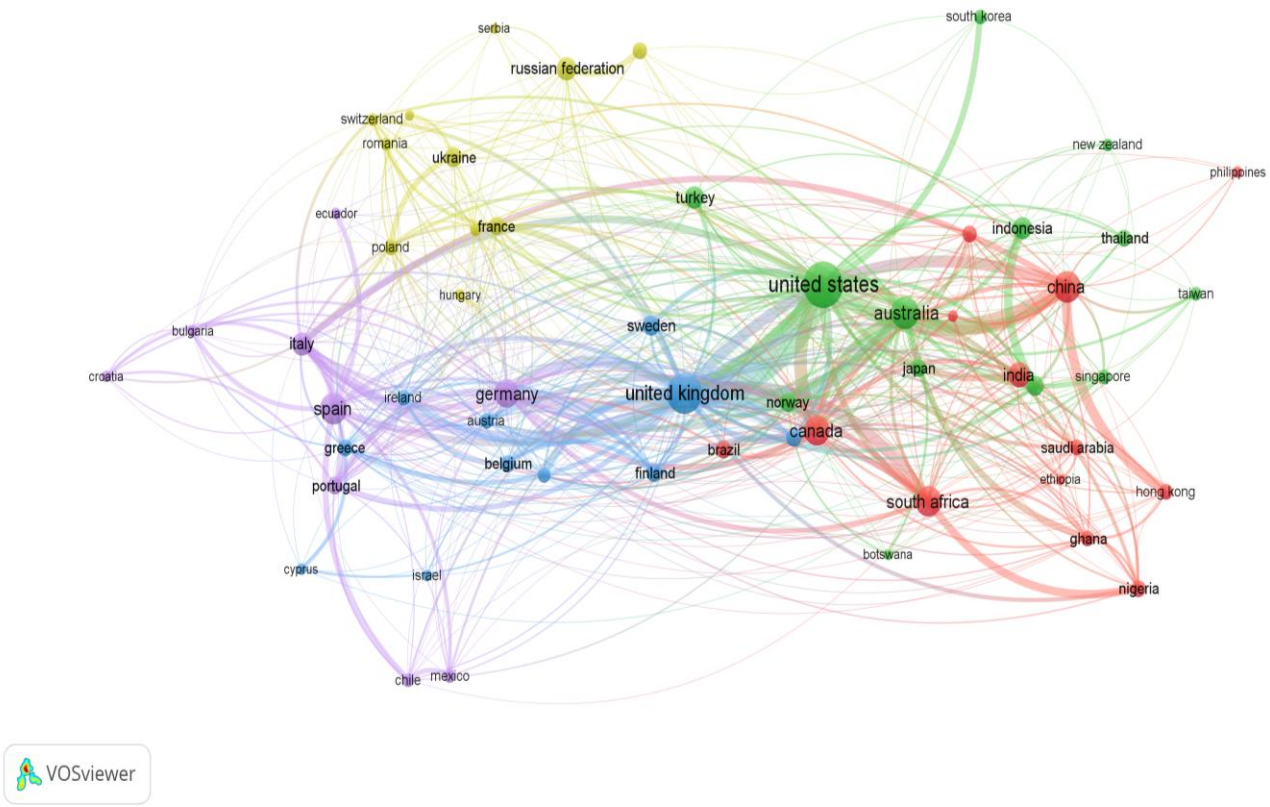

Figure 7 Network of collaboration between countries in SDG 4 research publications.

The United States and United Kingdom serve as central hubs in the SDG 4 co-authorship network, reflecting their extensive global collaborations. Countries such as China, Australia, South Africa, Canada, Spain, and Germany also hold prominent positions. In the network, line thickness represents the volume of co-authored publications, with thicker lines indicating stronger collaboration. These partnerships span both developed and developing nations, collectively advancing educational sustainability. The findings can guide stakeholders in identifying potential research collaborators and fostering strategic cooperation to support the SDGs.

3.8. Subject Orientation of SDG 4 Research

Table 8 provides a comprehensive analysis of the 15 leading subject areas that contribute to SDG 4, ranked by publication volume. The investigation revealed that Social Sciences dominated with 3,405 publications, while Computer Science and Psychology followed with 756 and 542 publications, respectively. In terms of total citations, Social Sciences again led the pack with 28,196, trailed by Computer Science at 9,058. Interestingly, when examining the average citations per publication, Arts and Humanities emerged as the frontrunner with 15.49, succeeded by Computer Science (11.98) and Health Professions (11.53).

This study offers a thorough examination of the academic disciplines contributing to SDG 4, emphasizing their influence in terms of publication volume and citation counts. The findings revealed that Social Sciences and Computer Science have made substantial contributions to research in this area. Furthermore, this study uses average citations per publication as a metric to gauge each discipline's impact, reflecting its influence and importance. The insights gained from this research will prove valuable for academics, decision-makers, and interested parties seeking to understand the primary academic fields that contribute to SDG 4 and their respective impacts.

Table 8 Subject area in which SDG 4 research was published.

Subject	TP	TC	C/P	h-index
Social Sciences	3405	28,196	8.28	62
Computer Science	756	9,058	11.98	36
Psychology	542	4,773	8.8	32
Arts and Humanities	461	7,142	15.49	40
Engineering	412	1,982	4.81	20
Medicine	353	2,394	6.78	23
Business, Management and Accounting	292	1,444	4.94	16
Health Professions	252	2,907	11.53	25
Environmental Science	227	1,597	7.03	17
Economics, Econometrics and Finance	166	716	4.31	13
Energy	150	1,240	8.26	16
Mathematics	123	859	6.98	15
Decision Sciences	89	336	3.77	10
Nursing	84	572	6.8	11
Multidisciplinary	68	309	4.54	9

TP = Total number of publications, TC = Total number of citations, C/P = Average citations per publication

3.9. Dynamics of Author Keywords

Keywords are crucial in shaping a research study's focus and main themes, facilitating the rapid identification of trends and areas of interest within a specific field (Gyanendra et al., 2022). This study conducted a co-occurrence analysis on 8303 author keywords from 4628 documents, requiring a minimum of three occurrences per keyword. The resulting map consisted of 911 keywords that met the threshold, forming 28 clusters with 9724 occurrences and a total link strength of 25864. The size of each frame in the network represented the number of occurrences (weights) of the corresponding keyword in the dataset, with larger size indicating a higher degree of co-selection. In this way, it was possible to identify the relationships between the keywords of the topic under study, based on the proximity within the map.

The co-occurrence map revealed a prominent cluster centred on "Inclusive Education," "Lifelong Learning," and "Quality Education" core principles of SDG 4. These keywords show strong interconnections with "Sustainable Development Goals" and "SDG4," as illustrated in **Figure 8**. This network reflects their collective importance in advancing the 2030 Agenda and underscores their centrality in promoting global educational sustainability.

Figure 8 Network visualization of the dynamic of author keywords

Keyword frequency and cluster distribution were analysed to complement the co-occurrence mapping. **Table 9** presents the 30 most frequently used keywords and their assignment to 28 clusters. Inclusive Education ranks highest with 1,224 occurrences (Cluster 2), followed by Lifelong Learning (776; Cluster 14). Quality Education and Sustainable Development Goals appear 144 and 58 times, respectively,

both in Cluster 6. The top 10 keywords are spread across the first 18 clusters, while five clusters contain no top-30 terms. Notably, Cluster 2 holds the largest number of high-frequency keywords.

Table 9 Frequency and cluster analysis according to author keywords (Top 30).

Keyword	Frequency	Link Strength	Cluster
Inclusive Education	1224	2818	2
Lifelong Learning	776	1368	14
Inclusion	314	874	2
Education	184	499	3
Disability	139	465	8
Special Education	132	372	5
Teachers	109	348	9
Attitudes	99	327	18
Higher Education	126	322	4
Quality Education	144	307	6
Teacher Education	80	227	1
Teacher Training	65	188	20
Sustainable Development Goals	58	176	6
Self-efficacy	54	167	23
Special Educational Needs	63	162	2
Diversity	51	153	15
Covid-19	45	141	1
Policy	42	141	9
Equity	47	139	7
Professional Development	53	138	4
Students with Disabilities	47	131	5
Sustainable Development	44	127	6
Adult Education	49	120	12
Learning	37	118	10
Ghana	34	117	13
Education Policy	37	115	7
Children with Disabilities	35	109	2
Artificial Intelligence	34	104	14
Attitude	37	102	5

3.10. Prolific Funding Agencies

Table 10 provides a comprehensive overview of the primary funding agencies that have been instrumental in supporting research on SDG 4. Notably, the European Commission is the most prominent agency in this research field, supporting 88 publications. Following closely are the National Natural Science Foundation of China (52 publications) and the Horizon 2020 Framework Programme (46 publications). These international organizations have played a crucial role in financing diverse research projects worldwide, significantly contributing to the advancement of the SDG 4. Among these leading funding agencies, the research supported by the German Research Foundation received the highest number of citations (TC = 2189) across 19 publications. Additionally, it achieved the highest average citation per publication (C/P) of 115.05. These remarkable figures highlight the foundation's substantial impact on research related to SDG 4.

The top 10 funding agencies mentioned above have collectively played a critical role in advancing SDG 4 by supporting research publications. Their contributions have been pivotal in generating knowledge and enhancing our understanding of the educational challenges.

Table 10 Top 10 Funding Agency in SDG 4 research publications

Funder	TP	TC	C/P
European Commission	88	952	10.81
National Natural Science Foundation of China	52	624	12
Horizon 2020 Framework Programme	46	514	11.17
National Science Foundation	38	521	13.71
Ministry of Science and Technology of the People's Republic of China	23	190	8.26
Social Sciences and Humanities Research Council of Canada	21	351	16.71
German Research Foundation	19	2,189	115.05
Japan Society for the Promotion of Science	19	204	10.73
Defense Advanced Research Projects Agency	18	429	23.83
UK Research and Innovation	18	290	16.11

TP = Total number of publications, TC = Total number of citations, C/P = Average citations per publication

4. DISCUSSION

The UN SDGs provide a global framework for addressing complex societal, economic, and environmental challenges. Among them, SDG 4 is critical due to its comprehensive approach to education and its foundational role in advancing the other 16 goals. As recognition of its importance grows, examining SDG 4's progress and challenges becomes increasingly essential. This study offers a global bibliometric analysis of SDG 4 research from 2015 to 2024, revealing a sharp rise in scholarly interest. The surge in publications reflects the urgency to address educational inequalities, with researchers actively contributing toward the 2030 Agenda's realization.

The study confirms that inclusive education and lifelong learning are dominant themes in SDG 4 research, reflected in frequently cited articles, leading journals, and influential publications. These topics align with global educational challenges. Their prominence highlights their role in promoting equity, resilience, and preparedness for an evolving world. Researchers are increasingly drawn to these areas for their cross-disciplinary impact and global relevance. The findings also emphasize the academic community's commitment to developing innovative, sustainable educational solutions.

The analysis reveals a strong concentration of SDG 4 research in developed countries, particularly the United States, United Kingdom, Australia, Spain, Canada, and Germany. These nations benefit from established research infrastructure enabling them to lead in educational development. However, the study also notes a growing research contribution from developing countries, reflecting increased awareness of SDG 4's relevance and the need to address region-specific educational challenges. This upward trend signals a positive shift toward a more inclusive global research landscape committed to advancing education for all.

This trend highlights the need for greater investment and engagement from developing countries in tackling global challenges related to educational sustainability. International collaboration remains a hallmark of SDG 4 research, fostering knowledge exchange, capacity building, and cross-border synergy. Such partnerships bring together diverse expertise and resources, improving the quality and reach of educational initiatives. Increased collaboration with researchers from developing nations may also support high-impact publications and attract research funding. Despite notable progress, key gaps remain that require immediate scholarly attention.

4.1. Implications and Future Directions

To accelerate progress toward SDG 4, future research should address key gaps such as inclusive policy development, equitable access to educational technology, and sustainable models for lifelong learning, particularly for women and informal sector workers. There is a need to strengthen teacher training in low-resource and conflict-affected areas, improve early childhood education for marginalized groups, and build crisis-resilient education systems. Additionally, efforts should focus on tracking progress in non-formal education, evaluating the role of civil society in accountability, and exploring innovative financing models to ensure universal, quality, and equitable education for all.

5. CONCLUSION

This study offered bibliometric analysis focusing on the patterns, pathways, and future directions of SDG 4. The analysis used data from the Scopus database from 2015 to 2024. SDG 4 have gained significant attention in recent years as a global framework for addressing pressing educational challenges. From 2015 to 2024, the number of publications exponentially increased, reflecting the growing interest and attention given to the SDG 4 by the academic community. However, various aspects of SDG 4 still remain underexplored. The results revealed that prevalent themes encompassed inclusive education and lifelong learning. These outcomes underscore the interdisciplinary essence of research on SDG 4 and emphasize the necessity for collaborative endeavours across diverse academic fields in tackling intricate educational issues.

It was evident that developed countries with established research infrastructure, such as the United States, the United Kingdom, Australia, Spain, Canada, and Germany, were the most prolific contributors. However, there was also a noticeable increase in research output from developing countries, reflecting a growing recognition of the SDG 4's relevance and the need to address specific regional challenges. The analysis delved into collaborative efforts and scholarly connections among researchers and institutions. International collaborations were prevalent, indicating that SDG 4 research is a global endeavour that transcends borders. The analysis also highlighted specific research gaps that require urgent attention.

This study, while making notable contributions, has limitations. It exclusively relied on the Scopus database, potentially overlooking relevant citations from other database sources. The manual screening process is time-consuming and challenging, and ongoing research may change citation counts. Addressing issues like author name ambiguity and non-uniform institution names is crucial. Our study identified potential redundancy in published works. While some repetition is normal, addressing this could free up research resources, enabling scholars to explore uncharted aspects of the SDG 4. Researchers should adapt methodologies to capture real-time insights, incorporating dynamic data sources like social media and policy documents for a more nuanced understanding. Future studies should leverage AI-powered text-mining tools across multiple databases to overcome these limitations.

REFERENCES

[1]. Boeren, E. (2019). Understanding Sustainable Development Goal (SDG) 4 on “quality education” from micro, meso and macro perspectives. *International Review of Education*, *65*(2), 277–294. https://doi.org/10.1007/s11159-019-09772-7

[2]. Chen, W., Geng, Y., Zhong, S., Zhuang, M., & Pan, H. (2020). A bibliometric analysis of ecosystem services evaluation from 1997 to 2016. *Environmental Science and Pollution Research*, *27*(19), 23503–23513. https://doi.org/10.1007/s11356-020-08760-x

[3]. Dignath, C., Rimm-Kaufman, S., Van Ewijk, R., & Kunter, M. (2022). Teachers’ Beliefs About Inclusive Education and Insights on What Contributes to Those Beliefs: A Meta-analytical Study. *Educational Psychology Review*, *34*(4), 2609–2660. https://doi.org/10.1007/s10648-022-09695-0

[4]. Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

[5]. Ekundayo, T. C., & Okoh, A. I. (2018). A global bibliometric analysis of Plesiomonas-related research (1990 – 2017). *PLOS ONE*, *13*(11), e0207655. https://doi.org/10.1371/journal.pone.0207655

[6]. Giangrande, N., White, R. M., East, M., Jackson, R., Clarke, T., Saloff Coste, M., & Penha-Lopes, G. (2019). A Competency Framework to Assess and Activate Education for Sustainable Development: Addressing the UN Sustainable Development Goals 4.7 Challenge. *Sustainability*, *11*(10), 2832. https://doi.org/10.3390/su11102832

[7]. 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. https://doi.org/10.3390/su11216136

[8]. Gyanendra, Y., Yumnam, G., Alam, W., & Singh, Ch. I. (2022). A bibliometric analysis and assessment of scientific studies trend on groundwater research in India during 1989–2020. *Arabian Journal of Geosciences*, *15*(16), 1417. https://doi.org/10.1007/s12517-022-10707-0

[9]. Hallinger, P., & Chatpinyakoop, C. (2019). A Bibliometric Review of Research on Higher Education for Sustainable Development, 1998–2018. *Sustainability*, *11*(8), 2401. https://doi.org/10.3390/su11082401

[10]. 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. https://doi.org/10.3390/su12051947

[11]. Hanemann, U. (2019). Examining the application of the lifelong learning principle to the literacy target in the fourth Sustainable Development Goal (SDG 4). *International Review of Education*, *65*(2), 251–275. https://doi.org/10.1007/s11159-019-09771-8

[12]. Hjørland, B. (2013). Facet analysis: The logical approach to knowledge organization. *Information Processing & Management*, *49*(2), 545–557. https://doi.org/10.1016/j.ipm.2012.10.001

[13]. Kessler, M. M. (1963). Bibliographic coupling between scientific papers. *American Documentation*, *14*(1), 10–25. https://doi.org/10.1002/asi.5090140103

[14]. Kioupi, V., & Voulvoulis, N. (2019). Education for Sustainable Development: A Systemic Framework for Connecting the SDGs to Educational Outcomes. *Sustainability*, *11*(21), 6104. https://doi.org/10.3390/su11216104

[15]. Maghsoudi, M., Shokouhyar, S., Ataei, A., Ahmadi, S., & Shokoohyar, S. (2023). Co-authorship network analysis of AI applications in sustainable supply chains: Key players and themes. *Journal of Cleaner Production*, *422*, 138472. https://doi.org/10.1016/j.jclepro.2023.138472

[16]. 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. https://doi.org/10.3390/su13042126

[17]. Saini, M., Sengupta, E., Singh, M., Singh, H., & Singh, J. (2023). Sustainable Development Goal for Quality Education (SDG 4): A study on SDG 4 to extract the pattern of association among the indicators of SDG 4 employing a genetic algorithm. *Education and Information Technologies*, *28*(2), 2031–2069. https://doi.org/10.1007/s10639-022-11265-4

[18]. Saloviita, T. (2020). Attitudes of Teachers Towards Inclusive Education in Finland. *Scandinavian Journal of Educational Research*, *64*(2), 270–282. https://doi.org/10.1080/00313831.2018.1541819

[19]. Silo, N., & Ketlhoilwe, M. J. (2020). Environmental Sustainability Education: Driving Towards Achieving SDG 4 Through Teacher Education. In S. O. Keitumetse, L. Hens, & D. Norris (Eds.),

Sustainability in Developing Countries (pp. 207–223). Springer International Publishing. https://doi.org/10.1007/978-3-030-48351-7_10

[20]. Tonegawa, Y. (2023). Education in SDGs: What is Inclusive and Equitable Quality Education? In S. Urata, K. Kuroda, & Y. Tonegawa (Eds.), *Sustainable Development Disciplines for Humanity* (pp. 55–70). Springer Nature Singapore. https://doi.org/10.1007/978-981-19-4859-6_4

[21]. UNESCO. (2020). *Education for sustainable development: A roadmap*. UNESCO. https://doi.org/10.54675/YFRE1448

[22]. UNESCO, UNICEF, World Bank, UNFPA, UNDP, UN Women, & UNHCR. (2015). *Education 2030: Incheon Declaration and Framework for Action for the Implementation of Sustainable Development Goal 4* (World Education Forum 2015, Incheon, Republic of Korea).

[23]. United Nations. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development* (United Nations General Assembly Resolution No. A/RES/70/1). https://sdgs.un.org/sites/default/files/publications/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

[24]. Van Eck, N. J., & Waltman, L. (2014). Visualizing Bibliometric Networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), *Measuring Scholarly Impact* (pp. 285–320). Springer International Publishing. https://doi.org/10.1007/978-3-319-10377-8_13

[25]. Weinberg, B. H. (1974). Bibliographic coupling: A review. *Information Storage and Retrieval*, *10*(5–6), 189–196. https://doi.org/10.1016/0020-0271(74)90058-8

[26]. Yada, A., Leskinen, M., Savolainen, H., & Schwab, S. (2022). Meta-analysis of the relationship between teachers' self-efficacy and attitudes toward inclusive education. *Teaching and Teacher Education*, *109*, 103521. https://doi.org/10.1016/j.tate.2021.103521

[27]. Ydo, Y. (2022). Reaching SDG 4: Our shared responsibility and renewed commitment to action. *PROSPECTS*, *52*(3–4), 223–229. https://doi.org/10.1007/s11125-022-09628-3

[28]. Zhang, L., Wang, M.-H., Hu, J., & Ho, Y.-S. (2010). A review of published wetland research, 1991–2008: Ecological engineering and ecosystem restoration. *Ecological Engineering*, *36*(8), 973–980. https://doi.org/10.1016/j.ecoleng.2010.04.029

Cite this Article

Muhammad Faiz, Muhammad Fawwaz Muhammad Yusoff, "GLOBAL RESEARCH TRENDS IN SUSTAINABLE DEVELOPMENT GOAL 4: A BIBLIOMETRIC ANALYSIS OF SCIENTIFIC PUBLICATIONS USING SCOPUS DATABASE (2015-2024)", *International Journal of Multidisciplinary Research in Arts, Science and Technology (IJMRAST), ISSN: 2584-0231, Volume 3, Issue 8, pp. 22-44, August 2025.*

Journal URL: *https://ijmrast.com/*

DOI: *https://doi.org/10.61778/ijmrast.v3i8.160*

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.